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ANNALES BIOLOGIQUES

VOLUME NO. II

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H. BLEGVAD
AVEC L'AIDE DE
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Environment. Hydrography: Atl.Sl., p. 28; NW-Area, p. 17; SNS, p. 44; Tr.A., pp. 83, 101;
Baltic, p. 148.
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The Fish. Cod Fishes: Tr.A., p. 102.
Cod: NE-Area, p. 7; SNS, pp. 50, 64; Tr.A., p. 91.
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Hake: Atl.Sl., p. 29.
Flatfishes: Baltic, p. 154.
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Eel: Tr.A., p. 98.
Lobster: Tr.A., pp. 100, 105.
Oysters: Tr.A., p. 105.
Waste Fish: Tr.A., p. 99.

PREFACE

IN my preamble to Vol. I of this series I mentioned that the International Council had agreed, in 1939, that its members should have an opportunity to discuss the general lines on which the contributions to this first issue would be compiled and arranged. As soon as conditions permitted the first volume was accordingly circulated to all those members of the Council whom we could reach. In an accompanying letter of June, 29th, 1945, I invited criticisms of this issue, both as to form and content, adding that the question would be discussed at the next meeting of the Council. This discussion took place in the Consultative Committee during the first post-war meeting of the International Council, which was held in Copenhagen, in October 1945 (Rapp. et Proc.-Verb. Vol. No. 116, I, p. 27). It was agreed that the period to be covered by Vol. II should be the years 1942—45 and that efforts should be made to secure a greater standardisation of figures and tables.

On November 15th, 1945, I therefore distributed to all Chairmen of Area and other Committees a scheme for the arrangement of the material to be printed in Vol. II, and I have been glad to see that the directions given in that scheme have largely been followed by the contributors. This has resulted in a greater uniformity in the arrangement of the material and I hope that this improvement together with the detailed list of contents will be helpful to the readers.

I would like to thank all the many authors — not only for their contributions, but also for the understanding shown and the endeavours made to achieve the standardisation requested. I also wish to thank Dr. Aage J. C. Jensen for valuable collaboration and Dr. M. Rehder for excellent work in assisting with the preparation of the material for publication.

Harald Blegvad.



The Areas and their Limits.
For the Transition Area see also the Map on p.84.

North-Eastern Area.

INTRODUCTION.

IN spite of the difficulties arising from the war situation, some important series of observations in the Norwegian fishery investigations were successfully maintained. A check was kept on both the stock of herring and on the stock of the skrei. But some important series of observations had also to be discontinued, i.e., the observations on the cod in the Barents Sea.

Owing to restricted liberty of movement on the sea, the work had to be altered to a certain degree. During this period new problems have been taken up, which will be continued in the future.

This volume contains reports from Gunnar Rollefson on the cod, Finn Devold on plaice and halibut and Birger Rasmussen on the deep sea prawn. The last report represents a new series in our investigations.

There are no reports on haddock, coal-fish and redfish.

Gunnar Rollefson.

THE FISH.

Norway.

The Cod (Skrei). (Gunnar Rollefson).

The sampling of material in the Lofoten area could be undertaken comparatively undisturbed. During all the years of war the Lofoten fishery was carried on with less participation than earlier but the quantity of fish caught did not seem to be diminished for that reason.

The table below gives various dates concerning the Lofoten fishery and the skrei material collected.

In Fig. 1 is shown the length distribution of the skrei during the years 1940—45. The curves indicate a renewal of the stock in 1943 and 1945, and the age distribution in Fig. 2 shows that this is the case. In 1940 the year-classes 1929 and 1930 were strongly dominant but subsequently

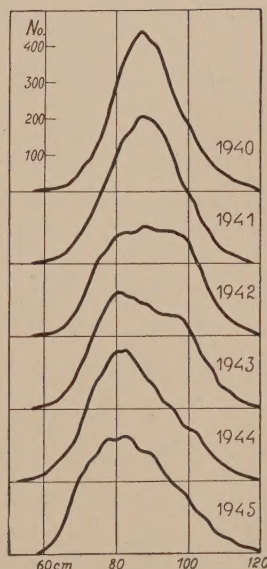


Fig. 1. Length Distribution of the Skrei, 1940—1945.

Year	No. of Fishermen	No. of Skrei in millions	Average Weight	No. of Skrei measured	No. of Skrei age determined
1940	23.515	24,7	3,80	51.340	3,207
1941	14.984	22,6	3,76	40.141	2,420
1942	16.260	21,2	3,71	32.886	3,950
1943	16.170	15,8	3,69	33.825	3,208
1944	17.015	23,7	3,67	41.003	4,545
1945	16.100	19,0	3,58	23.195	2,788

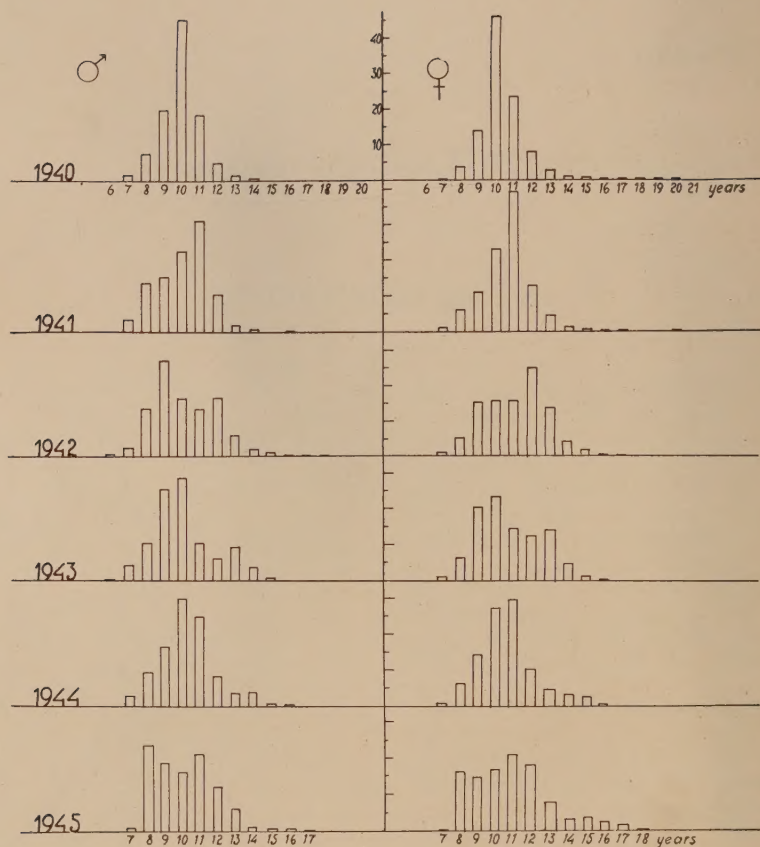


Fig. 2. Age Distribution of the Skrei, 1940—45.

declined. They are replaced by the year-class 1934. The year-class 1937 seems especially to be of considerable size.

In Ann. Biol., Vol. I., p. 21, there is given a curve (Fig. 4) showing the change in average length of the skrei.

On account of the incomplete material from the years 1938—1940 this curve is misleading.

Fig. 3 shows the same curve brought up to date and corrected. The values given in the curve are based on the length of individuals of the same age for each year.

Fish of the same age, i.e., the age-groups 8—13 years ♂-♀ in 1932 had an average length of about 84 cm. In 1936 the average length of the same age-groups was about 92.5 cm., and in the years following the mean length has decreased.

This change in the growth increase suggests that the skrei during its stay in the feeding area is subjected to varying food conditions.

Mortality. The observations on the age composition of the skrei have lasted so long that it is possible to undertake a calculation of the mortality by the same method as that used by [unintelligible] for the herring.¹⁾ According to this method the calculation of the mortality of the skrei will be about 50 % per year. Many things however suggest that the rate of mortality is correlated with the size of the individual. This problem therefore has to be subjected to special investigations.

¹⁾ Mortality in the Tribe of Norwegian Herring. *et Proc. Verb.*, Vol. LXV, 1930.

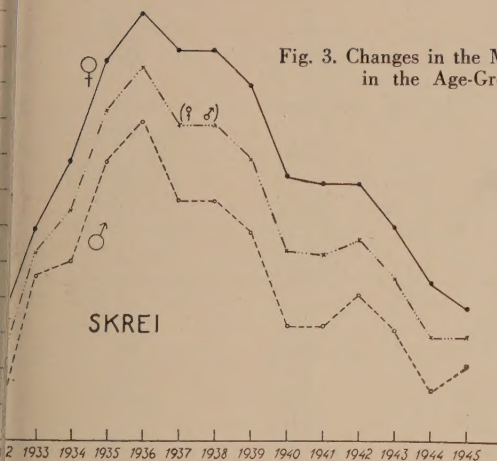


Fig. 3. Changes in the Mean Values of the Average Lengths in the Age-Group 8—13 Years (Skrei).

Plaice and Halibut. (Finn Devold).

No samples of **plaice** have been collected during the war in Norwegian waters. We therefore can give no further data as to the plaice than that previously published in Ann. Biol., Vol. I, p. 28.

Samples of **halibut** are not collected, but we have received some halibut tags from the marking experiments in 1938. A list of the recoveries is published in Ann. Biol., Vol. I, and the records can be supplemented by the following:

Records of Halibut recaptured, marked in the Andfjord at 69°15'N. 16°22'E.

(Supplement to Table 1. Ann. Biol., Vol. I, p. 36.)

Total Number marked: 44. Total recaptured 13, up to 1/2-46.

Date marked	Size cm.	Locality of Recovery	Date of Recovery	Days at Liberty	Naut. Miles travelled	Nationality of Vessel
13/2-38	147	69°23'N., 16°48'E.	10/4-43	1882	11	Norwegian

Records of Halibut recaptured, marked at the Northbank, 1938.

(Supplement to Table 2. Ann. Biol. Vol. 1, Page 37.)

Total Number marked 200. Total recaptured 30, up to 1/2-46.

Liberated at 71°05'N. 31°47'E.

Date marked	Size cm.	Locality of Recovery	Date of Recovery	Days at Liberty	Naut. miles travelled	Final Size	Nationality of Vessel
30/3-38	69	70°59'N., 29°05'E.	2/6-42	1525	54	82 cm.	Norwegian
5/4-38	79	62°49'N., 4°25'E.	16/6-43	1898	ca.370	26 kg.	Norwegian

Records of Halibut recaptured, marked off Spitsbergen, 1938.

(Supplement to Table 3. Ann. Biol. Vol. 1, Page 38.)

Liberated at 78°47'N. 9°20'E.

Total Number marked 37, recaptured 5 up to 1/2-46.

6/8-38	89	69°23'N., 16°40'E.	27/7-45	2547	ca.570	31 kg.	Norwegian
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Records of Halibut recaptured, marked off Söröy 70°58'N. 23°00'E.

Total Number marked: 26, recaptured 5 up to 1/2-46.

11/4-38	59	70°54'N., 22°57'E.	2/9-38	144	10	—	Norwegian
11/4-38	57	70°54'N., 22°57'E.	21/9-38	163	10	—	Norwegian
11/4-38	66	70°54'N., 22°57'E.	—	—	—	—	Norwegian
11/4-38	50	70°23'N., 20°02'E.	20/4-44	2201	75	ca.4 kg.	Norwegian
11/4-38	98	71°00'N., 23°38'E.	12/7-38	92	5	98 cm.	Norwegian

Notes on the Deep Sea Prawn in a Norwegian Fjord. (Birger Rasmussen).

An extensive study of the biology of the deep sea prawn (*Pandalus borealis*) has been taken up in recent years. The prawn of British Columbia has been studied by Alfreda Berkeley (1932), the prawn of the Gullmar Fjord, Sweden, by G. Jägersten (1936). F. Leopoldseder has examined deep sea prawns collected at Herdla near Bergen, Norway. The most important result of these investigations was the discovery that the deep sea prawn is a protandric hermaphrodite, i.e., the prawns mature first as males, and thereafter as females, and remain females for the rest of their lives. On this basis Hjort and Ruud (1933) studied the deep sea prawn in the Oslo Fjord. In all localities investigated, the rate of growth and sexual development has been found to be much the same.

By the present author the work on the deep sea prawn was taken up in 1942. A preliminary report has been published on the prawn in Spitsbergen waters (1942), on the prawn in the Vigråfjord (1945), and a summary of the results (1946). At Spitsbergen the growth and development of the deep sea prawn was much slower than in other localities examined. Later investigations on various prawn populations along the Norwegian coast indicate that growth and sexual development are apparently influenced by environment. In the following is given a short review on the Vigråfjord prawn.

Spawning takes place from the middle of September to the end of October. The egg-bearing period lasts about 5½ months. The eggs hatch from early March to the middle of April.

The growth of the prawns as it appears in samples from the trawl catches is shown in Fig. 1 A-T. Small prawns measuring on the average 4.4 cm. are caught at the end of September, in the same year they are hatched (A). When 1 year old they measure 6.9 cm. (D) and 1½ year 8.8 cm. (F). The great majority are then sexually mature and function as males. A few specimens, however, form an exception and mature as females at this age. (G-M, white columns).

The growth of the functioning males is strongly retarded during the breeding season. At the end of December the group of males suddenly splits into two fractions, one retaining the male characters, the other changing into females. (I-M-T). It is the larger individuals of the group which become females, and these latter have also an accelerated rate of growth compared with the remaining males. Thus a part of the age-group becomes ovigerous females 2½ years old, while others function as males for the second time at the same age. During the following year also these last remaining males will change their sex and spawn as females for the

first time when 3½ years old (N-S-T). In some of these latter will merge with the one year young ovigerous prawns (T).

The size distribution of the various year-classes is shown in Fig. 2 where diagrams have been made from a few selected samples. The figure also gives an idea of how the composition of the catches changes according to the season.

In September 1943 large prawns of the 1942-class are well represented. Their size varies between 10 and 15 cm., the average size being 12 cm. In January 1944 the 1942-class reaches its maximum strength in the catches. This class consists of smaller individuals measuring 7.5—11 cm., averaging 9.1 cm. In March and May of the same year this year-class begins to lose its dominance while the new 1943-class enters into the catches and rapidly gains in strength. In May the individuals of this latter year-class measure 6—9 cm. averaging 7.3 cm.

The sex-composition in the catches also varies according to the season. This is shown in Fig. 3. In September 1943 (lower diagram) the sex-composition is as follows: (1) a group of small-sized young prawns about 6 months old which have not as yet attained maturity as males, (2) a dominating group about 1½ years old consisting of sexually mature males, and (3) two groups of prawns about 2½ years old of which one contains sexually mature males and the other large berried females. In January the picture changes somewhat. Some of the 1¾ years old males (the large ones) enter the transitory stages to females, and the catch is now composed of small males, medium-sized transitional animals and large berried females. In March the sex composition is about the same. In May the picture again changes somewhat, and now we find the following groups: (shown from left to right upper diagram). (1) a group of medium-sized one-year-old prawns which will ripen into males next autumn, (2) a group of large 2-year-old prawns which will function as males for the second time next autumn, (3) a group of rapidly-growing transitional prawns 2 years old which will ripen into females, and (4) a group of older spent females.

From the material collected we can also obtain a fairly satisfactory picture of the probable fate of a single year-class of prawns (Fig. 4). When 6 months old a few individuals will enter into the catches, but the year-class does not appear in earnest till about one year old, when it constitutes about 20% of the catch. The number increases rapidly as the prawns grow in size, and when 1½ years old a single year-class constitutes about 90% of the catch. From now on the numerical strength of the year-class in the catches decreases rapidly. When 2 years old it constitutes 67%

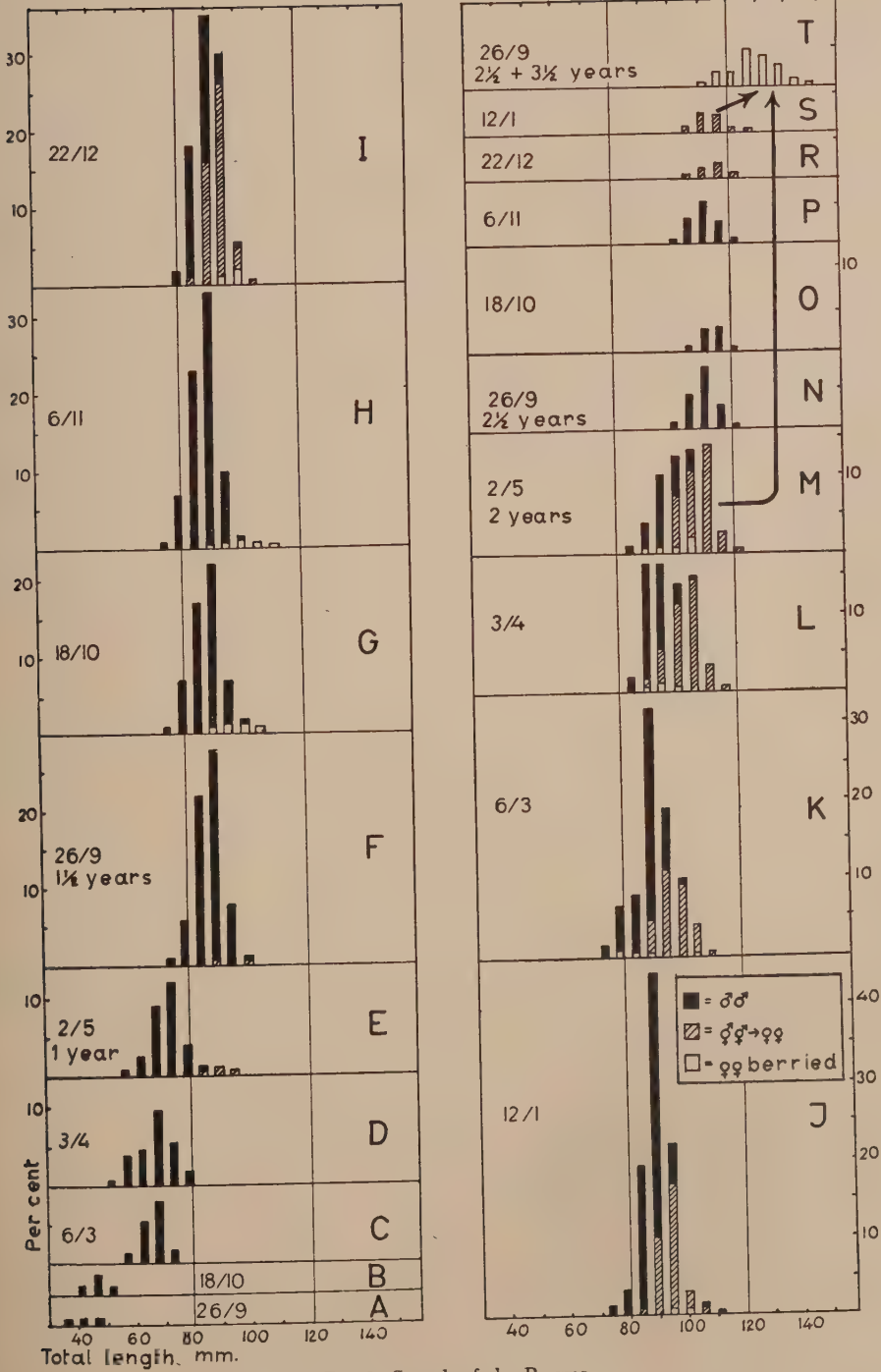


Fig. 1. Growth of the Prawns.

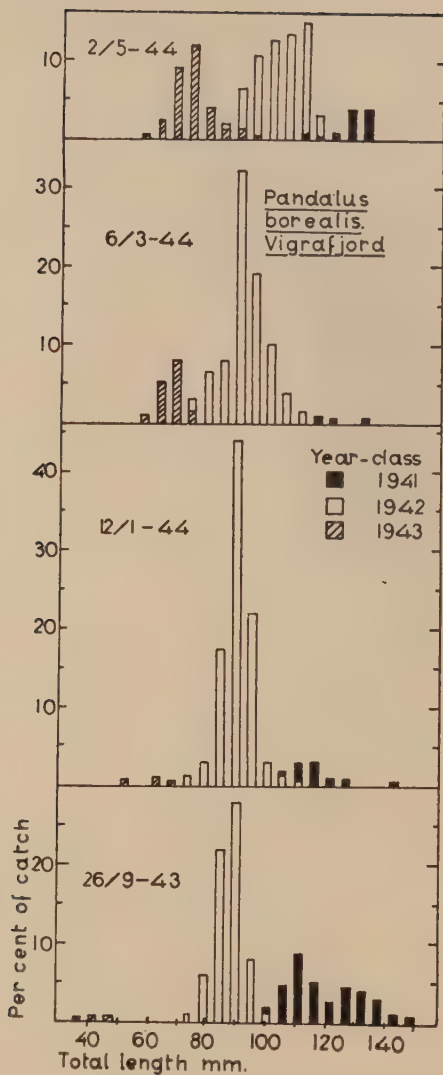


Fig. 2. Size Distribution.

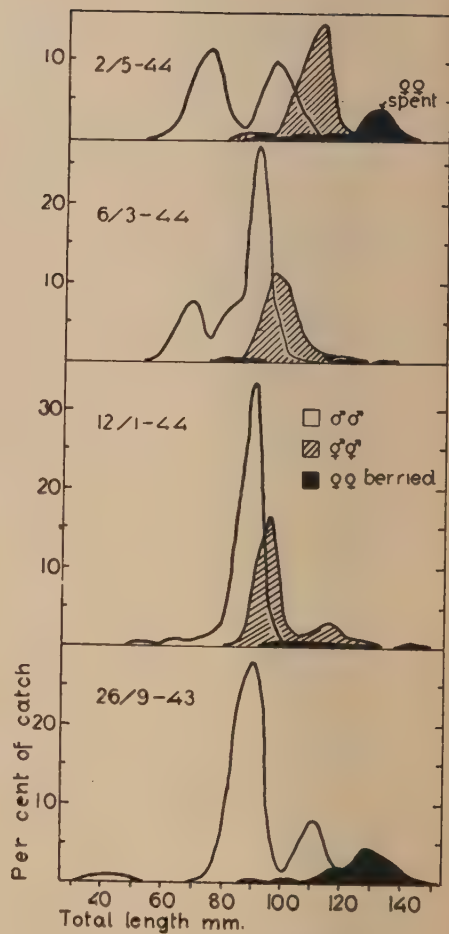


Fig. 3. Sex-Composition.

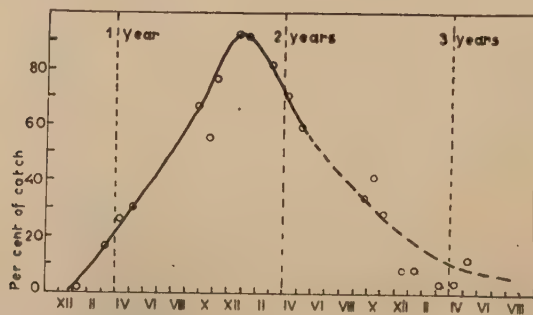


Fig. 4. Probable Fate of a single Year-Class.

one month later 59 % of the catch. On account of the subsequent composite nature of the total development and growth it is rather difficult to trace with exactness the later rate of decrease. The broken line on the figure gives, however, the probable course of decrease. The 3-year-old prawns should constitute only about 10 % of the catch and are of no real significance any longer. We may assume that mortality due to natural causes is high after a life-span of two years, at present it cannot be stated how the commercial fishery affects a prawn population.

The taxation and protection of a prawn population on a trawl ground must be regarded on the background of the life history of the prawn in that particular locality and the kind of fishing gear used. The catches in the Vigrafjord treated here, have been taken with a trawl of ordinary mesh, 36 knots pr. Norw. ell (ab. 15 mm. bar on wet net, or 14 mm. wet). The importance of saving undersized non-marketable prawns is emphasized by the peculiar life history of the deep sea prawn. The question of the proper mesh size in this connection has been thoroughly treated by Hjort and Ruud (1938). Bjerkkan (1939) indicates the possible use of a special fishnet

(flapper) and closing device in the cod-end as a possible means for saving the small prawns. The present author hopes in the near future to be able to test the effect of the latter gear combined with investigations on the life history of different prawn populations.

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North-Western Area.

INTRODUCTION.

Contributors to this report from the North-Western area are:

Mr. R. S. Clark, Aberdeen.
Mr. B. B. Rae, Aberdeen.
Mr. Jens Smed, Copenhagen.
Mr. Å. Vedel Tåning, Copenhagen.

MEMBERS of this Committee have been able to contribute very little material to this report, owing mainly to two circumstances. Firstly, the military operations 1940—1945 have largely prevented some countries from carrying out investigations in the area, or from arranging the collection of material, e.g., from commercial fishing vessels, was made; secondly, the staff available in the various laboratories, on resuming work after the end of the war, has, as yet, not been able to study the material collected in the area during the war and the ensuing short period of peace to a small extent. All powers available have had to be employed in reorganization of work. Only gradually as the work returns to its usual routine may the results be expected. *Furthermore* it should here be mentioned that reports from Iceland fishing grounds concerning observ-

ations during the war period on the stocks of cod, haddock, herring etc. will appear when the large amount of material has been dealt with by Mr. Árni Friðriksson and collaborators; and from the West-Greenland waters may be expected an extensive report (by Mr. Paul M. Hansen) on the stock of cod, as a very large material for age-assessment etc. has been collected here during the years of war. Moreover it can be stated that a fairly large number of cod marked before the war and recaptured during the war has been forwarded from Greenland and Iceland, and this material will be reviewed later on in this report.

With regard to hydrographical observations of value for the study of conditions in the sea in the present vast area, extremely little has unfortunately been obtained during the war, and we have to realize that such a material cannot be expected to be available for the long period of the years 1940—45. Based on observations from about 60 years previous to the second world war, a study by Mr. Jens Smed on the monthly anomalies of the surface temperature off West and South Greenland shows very clearly a rise in the temperature during the last third of the period.

Å. Vedel Tåning.

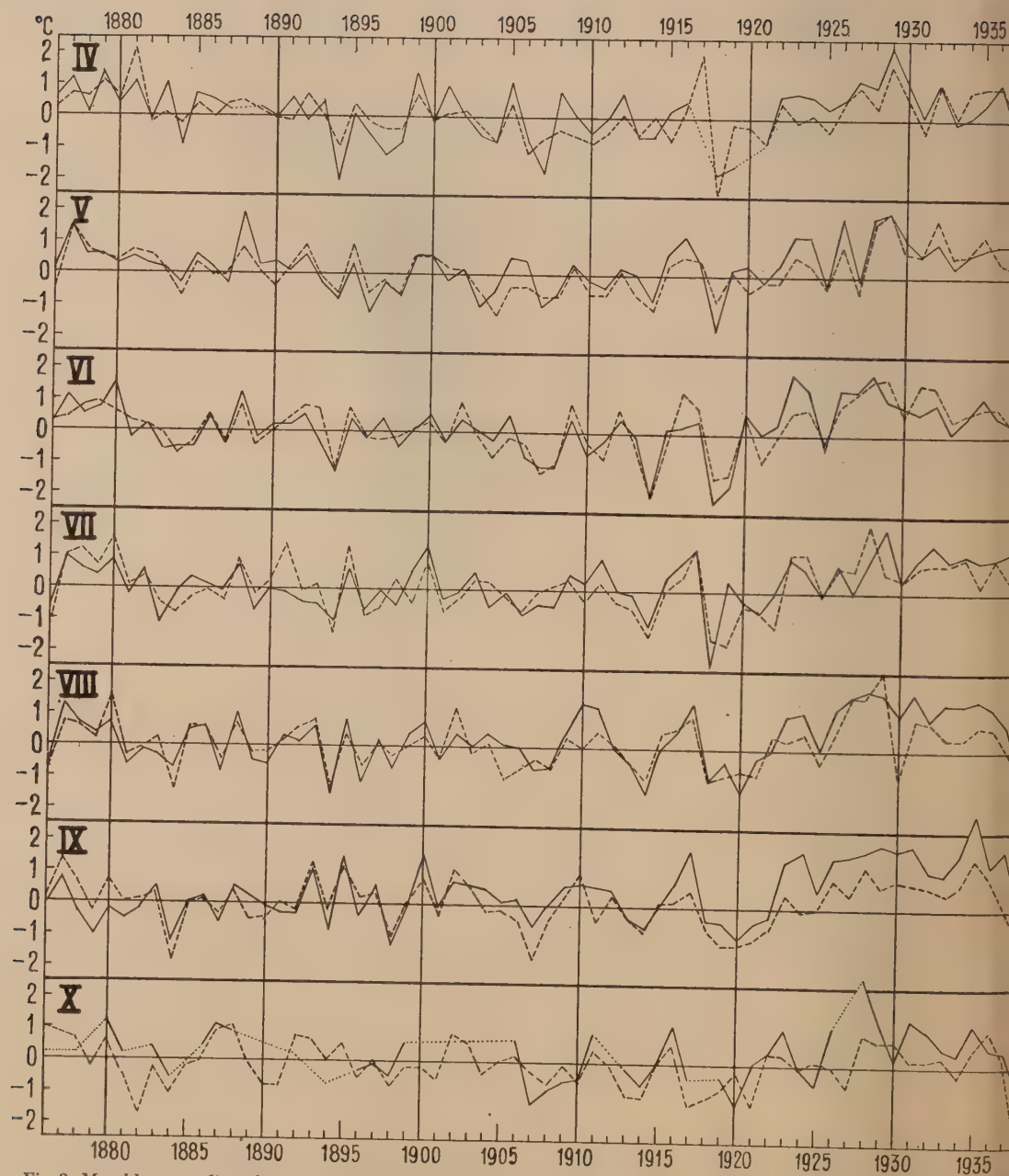


Fig. 2. Monthly anomalies of the surface temperature in the areas A and B (see Fig. 1) during the years 1876—1939.
Solid lines: area A; dashed lines: area B.

HYDROGRAPHY

Monthly Anomalies of the Surface Temperature in the Sea round South Greenland during the Years 1876—1939.

As has been proved by several scientists, a remarkable increase of the surface temperature has taken place since about 1920 in great parts of the North Atlantic and in the Arctic seas. A survey on this subject has been given by Scherhag (1937).

For the sea round Greenland, where the temperature rise is very conspicuous, the phenomenon has been treated by A. d. S. Jensen (1939) who reports on the great increase in the stock of fish in these waters during the same years.

In view of the fact that the rise of temperature has influenced the fish stock to a considerable degree in these waters, it may be of some interest to make a comprehensive survey of the variation of

ed observations of surface temperature from passenger and cargo vessels crossing the North Atlantic since 1876. During the years 1912—1939 the relevant issues of the *Nautisk Meteorologisk Aarbog* contain for each month of the year in question mean values of the observations in each 1°-square, i.e., an area limited by lines with integer numbers of latitude and longitude. These mean values have been used directly in the present investigation. For the years 1895—1911 the material has been published in a slightly different form; for these years, as well as for the years 1876—1894, lists of monthly mean values were, however, kindly placed at my disposal by Helge Thomsen, Head of the Nautical Section of the Danish Meteorological Institute. The material for the period 1876—1915 has been worked up by Ryder (1917) who gives, i.e., grand monthly means of the temperature for each 1°-square for the period mentioned.

After an inspection of the material at my disposal it was found advisable to work together material from the same period — one month — from areas comprising a great number of 1°-squares. In Fig. 1 are shown the areas chosen, viz. A: 55°—70° N., 50°—58° W., and B: 55°—63° N., 40°—50° W. On the basis of Ryder's mean values the temperature anomaly for each 1°-square and for each month was computed. These anomalies were averaged for the areas A and B for each of the months in the whole period 1876—1939. By this procedure the local variation of the temperature should not in any appreciable degree influence the results. At this averaging the weight of the means for each of the 1°-squares indicated by the number of observations in the square was duly considered.

Tables 1 and 2 give, for the areas A and B respectively, the resulting monthly mean anomalies (Δ) as well as the number (n) of observations on which each of these mean anomalies is based. For the months January and February the material contained no observations from the areas A and B; nor did it contain any observation for December from the area A.

A graphical representation of the results for the months April—October, as contained in Tables 1 and 2, is given in Fig. 2. Material from March, November and December being rather scarce, the results for these months are not given as graphs.

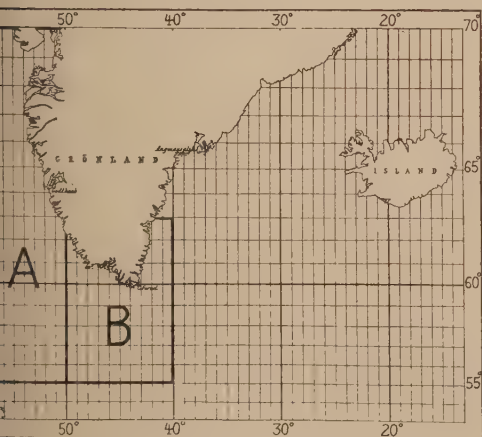


Fig. 1. Location of the areas considered, A and B.

surface temperature in the sea in question during a period of some length. In the following will be given such a survey, based on the temperature material collected in the years up to 1939 by the Danish Meteorological Institute. An extension of the investigation to the years 1940—1945 was not carried out on account of the fact that only very scarce material is as yet available. Should sufficient material from these years be available, it is intended to treat these observations in the *Annales Biologiques* together with the data for 1946.

The Danish Meteorological Institute has collect-

Table 1.
Monthly Anomalies ($\Delta^{\circ}\text{C}$) and Numbers (n) of Observations of the Surface Temperature in the Area A
(see Fig. 1) during the years 1876—1939.

	March		April		May		June		July		Aug.		Sept.		Oct.		Nov.	
	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n
1876	—	—	0.6	14	0.2	20	0.3	14	-0.7	20	-0.6	37	0.0	25	0.2	5	—	—
1877	—	—	1.2	42	1.5	39	1.1	56	0.9	58	1.3	65	0.8	46	—	—	—	—
1878	—	—	0.1	38	0.6	45	0.5	81	0.6	67	0.7	72	-0.3	55	0.2	7	—	—
1879	—	—	1.4	31	0.6	29	0.7	111	0.4	82	0.4	110	-1.0	8	—	—	—	—
1880	—	—	0.4	21	0.3	27	1.5	74	0.9	82	0.7	94	-0.2	27	1.2	11	—	—
1881	—	—	1.1	18	0.5	53	-0.2	96	-0.2	88	-0.6	124	-0.5	39	0.2	6	—	—
1882	—	—	-0.1	27	0.3	35	0.2	68	0.5	82	-0.2	110	-0.2	41	—	—	—	—
1883	—	—	1.0	1	0.2	66	-0.6	64	-1.1	43	-0.3	114	0.5	14	0.4	7	—	—
1884	—	—	-0.9	33	-0.3	54	-0.5	29	-0.1	79	-0.7	63	-1.2	41	-0.6	33	—	—
1885	—	—	0.7	24	0.6	26	-0.5	68	0.3	39	0.5	79	0.0	43	—	—	—	—
1886	—	—	0.5	11	0.2	58	0.4	121	0.1	46	0.6	105	0.2	28	0.4	28	—	—
1887	—	—	0.2	40	-0.3	35	-0.4	57	-0.1	104	-0.8	79	-0.6	31	1.1	3	—	—
1888	—	—	—	—	1.9	12	1.2	92	0.7	69	1.0	65	0.5	6	0.9	17	—	—
1889	—	—	0.3	12	0.3	23	-0.2	62	-0.7	101	-0.5	69	0.2	40	—	—	—	—
1890	—	—	0.0	15	0.4	31	0.2	80	0.0	77	-0.6	82	-0.1	21	—	—	—	—
1891	—	—	0.6	7	0.1	17	0.2	129	-0.1	65	0.3	112	-0.3	1	—	—	—	—
1892	—	—	-0.1	25	0.6	37	0.5	118	-0.4	81	0.1	79	-0.3	55	0.3	1	—	—
1893	—	—	0.5	1	-0.3	54	-0.3	106	-0.5	87	0.6	94	1.1	69	—	—	—	—
1894	—	—	-2.0	14	-0.8	74	-1.3	151	-1.0	40	-1.5	78	-0.8	67	-0.7	8	—	—
1895	—	—	0.1	36	0.3	68	0.4	103	0.6	73	0.8	102	1.4	65	—	—	—	—
1896	—	—	-0.6	18	-1.2	52	-0.2	108	-0.7	36	-1.1	122	-0.4	92	-0.3	3	—	—
1897	—	—	-1.2	2	-0.3	22	0.4	99	-0.1	90	0.2	89	0.5	66	-0.1	12	—	—
1898	—	—	-0.8	9	-0.6	70	-0.5	170	-0.5	18	-0.7	87	-1.3	62	-0.5	10	—	—
1899	—	—	1.3	31	0.6	70	0.1	77	0.6	14	0.4	106	-0.1	55	0.6	18	—	—
1900	—	—	-0.2	19	0.6	47	0.5	136	1.3	40	0.8	88	1.6	8	—	—	—	—
1901	—	—	0.9	3	-0.2	50	-0.3	104	-0.3	51	-0.4	101	-0.1	41	—	—	—	—
1902	—	—	0.0	49	0.1	51	0.4	98	-0.1	57	0.4	68	0.7	17	—	—	—	—
1903	—	—	-0.6	41	-1.0	56	0.0	62	0.5	49	0.0	78	0.6	44	—	—	—	—
1904	—	—	-0.8	6	-0.5	94	-0.3	73	-0.5	33	0.4	80	0.5	25	—	—	—	—
1905	—	—	1.0	3	0.5	49	0.5	53	-0.1	61	0.1	55	0.1	16	—	—	—	—
1906	—	—	-0.8	13	0.4	73	-0.8	32	-0.8	22	0.0	83	0.2	59	0.7	4	—	—
1907	—	—	-1.8	57	-1.0	73	-1.1	74	-0.5	42	-0.7	74	-0.7	37	-1.3	9	—	—
1908	—	—	0.8	33	-0.6	64	-1.1	71	-0.5	47	-0.6	91	0.6	64	-0.9	11	—	—
1909	—	—	0.0	31	0.3	87	0.4	60	0.5	19	0.5	78	0.6	31	-0.6	6	—	—

Table 2.
Monthly Anomalies ($\Delta^{\circ}\text{C}$) and Numbers (n) of Observations of the Surface Temperature in the Area B
(see Fig. 1) during the years 1876—1939.

	March		April		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.	
	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n	Δ	n
1876	—	—	0.3	21	—0.4	33	0.3	72	—1.0	13	—0.7	40	0.2	50	1.0	15	—	—	—	—
1877	0.5	3	0.7	79	1.5	41	0.4	48	1.0	51	0.7	20	1.4	56	0.8	29	—	—	—	—
1878	—	—	0.6	79	0.8	82	0.8	61	1.2	17	0.6	78	0.7	43	0.6	28	—	—	—	—
1879	—	—	1.1	69	0.5	51	0.9	91	0.7	39	0.2	81	—0.2	34	—0.2	2	—	—	—	—
1880	—	—	0.6	68	0.4	68	0.6	81	1.6	46	1.6	74	0.8	33	0.6	14	—	—	—	—
1881	—	—	2.1	41	0.7	71	0.3	55	0.1	52	—0.3	60	0.0	59	—0.5	36	—	—	—	—
1882	—	—	—0.2	75	0.6	54	0.2	78	0.4	34	—0.1	53	0.1	73	—1.7	23	—	—	—	—
1883	—	—	0.1	40	0.1	66	—0.1	39	—0.5	26	0.2	78	0.3	48	—0.3	18	—	—	—	—
1884	—	—	—0.2	47	—0.7	59	—0.7	50	—0.8	43	—1.4	65	—1.8	47	—1.1	36	—	—	—	—
1885	—	—	0.4	55	0.3	54	—0.3	34	—0.3	43	0.6	32	0.0	49	—0.2	36	—	—	—	—
1886	—	—	0.0	61	0.0	25	0.5	72	—0.1	45	0.6	50	0.1	71	0.0	39	—	—	—	—
1887	—	—	0.4	51	0.0	33	—0.3	72	—0.4	33	—0.5	83	—0.3	30	0.9	49	—	—	—	—
1888	—	—	0.5	9	0.8	56	0.8	91	0.9	49	0.7	52	0.4	23	1.1	27	—	—	—	—
1889	—	—	0.3	19	0.1	17	—0.4	56	—0.2	53	—0.2	51	—0.5	35	—0.1	8	—	—	—	—
1890	—	—	0.0	34	—0.4	64	0.0	45	0.2	42	—0.2	79	—0.4	38	—0.8	9	—	—	—	—
1891	—	—	—0.1	32	0.2	39	0.4	88	1.4	16	0.2	67	0.0	35	—0.8	12	—	—	—	—
1892	—	—	0.7	44	0.9	35	0.8	62	—0.1	32	0.6	44	—0.2	53	0.8	41	—	—	—	—
1893	—	—	0.1	36	—0.1	56	0.7	69	0.1	45	0.8	39	1.3	101	0.7	8	—	—	—	—
1894	—	—	—0.9	89	—0.6	52	—1.1	48	—1.4	52	—1.3	44	—0.2	42	0.0	37	—	—	—	—
1895	—	—	0.4	45	0.9	29	0.7	56	1.3	39	0.4	73	1.2	56	0.5	16	—	—	—	—
1896	—	—	—0.2	48	—0.6	47	—0.2	79	—0.9	24	—0.6	38	0.2	52	—0.5	25	—	—	—	—
1897	0.2	8	—0.4	18	—0.2	49	—0.3	43	—0.6	68	0.1	46	0.3	48	0.0	25	—	—	—	—
1898	—	—	—0.4	44	—0.7	48	—0.2	86	0.3	17	—0.3	71	—1.0	60	—0.8	34	—	—	—	—
1899	0.3	8	0.7	61	0.6	74	0.1	45	—0.4	58	0.0	85	0.1	44	—0.2	50	—	—	—	—
1900	—	—	—0.1	17	0.5	54	0.3	93	0.8	43	0.3	82	0.8	36	—0.2	23	—0.2	17	—	—
1901	0.7	3	0.1	56	0.2	75	—0.3	80	—0.7	54	—0.4	94	0.3	56	—0.6	33	—	—	—	—
1902	—	—	0.2	65	0.1	49	0.9	91	—0.3	51	1.2	76	1.1	42	0.9	38	0.2	1	—	—
1903	—	—	—0.3	65	—0.6	43	—0.1	95	0.3	64	—0.2	69	0.6	70	0.6	18	0.8	4	—	—
1904	—	—	—0.8	61	—1.3	29	—0.8	79	0.2	24	0.1	57	—0.2	65	—0.4	15	—	—	—	—
1905	—1.0	2	0.4	13	—0.4	36	—0.2	67	—0.2	21	—1.0	77	—0.2	35	0.0	11	—	—	—	—
1906	—0.7	4	—1.1	64	—0.4	94	—0.4	58	—0.7	86	—0.7	60	—0.5	76	0.2	29	—	—	—	—
1907	—	—	—0.7	80	—0.7	55	—1.3	82	—0.1	70	—0.4	42	—1.7	68	—0.3	58	—	—	—	—
1908	—	—	—0.4	71	—0.7	51	—1.0	86	0.1	59	—0.7	64	—0.5	87	—0.7	38	—	—	—	—
1909	0.0	3	0.6	63	0.2	46	0.9	77	0.3	51	0.3	52	0.2	48	—0.1	43	—	—	—	—

1912	-0.2	18	0.1	94	0.1	98	0.7	77	0.2	92	0.2	12	0.2	89	-0.4	89	-1.0	98	0.2	24
1913	-	-	-0.5	111	-0.7	189	-0.3	114	-0.6	54	-1.0	137	-	-	-0.8	126	-1.1	82	-	-
1914	-0.8	6	0.0	135	-1.1	111	-2.0	77	-1.5	101	0.5	52	0.5	52	0.1	125	0.0	84	-0.5	36
1915	-	-	-0.7	77	0.3	38	-0.3	103	0.0	97	0.5	116	0.6	116	0.2	98	0.6	93	-0.4	44
1916	-0.1	4	0.3	139	0.6	114	1.3	7	0.4	13	0.4	13	0.6	116	0.2	98	0.6	93	-0.4	44
1917	-	-	2.0	1	0.5	74	0.8	91	1.3	32	1.0	78	1.0	78	0.5	97	-1.3	60	-0.4	29
1918	-2.5	1	-2.4	51	-0.8	62	-1.4	65	-1.5	111	-1.0	61	-1.0	61	-0.7	125	-1.1	71	-1.9	95
1919	-	-	-0.2	54	0.1	69	-1.3	89	-1.7	43	-0.8	168	-0.8	168	-1.2	48	-0.8	87	0.7	55
1920	-	-	-0.3	27	-0.5	47	0.4	36	-0.5	112	-0.7	93	-0.7	93	-1.2	153	-0.2	47	-1.7	34
1921	-	-	-0.8	53	-0.2	76	-0.9	112	-0.6	102	-0.8	164	-0.8	164	-1.0	89	-1.3	62	0.1	43
1922	-	-	0.5	40	-0.2	133	-0.1	33	-1.1	189	0.4	84	0.4	84	-0.6	158	0.4	51	-0.5	32
1923	-0.5	13	-0.1	109	0.6	47	0.7	58	1.2	77	0.3	97	0.3	97	0.4	77	0.3	78	0.4	26
1924	-	-	0.1	62	0.3	59	0.8	91	1.2	100	0.5	108	0.5	108	-0.1	93	-0.1	57	0.1	53
1925	-	-	-0.4	110	-0.3	150	-0.2	125	-0.1	138	-0.4	140	-0.4	140	0.0	80	0.1	55	0.7	78
1926	-0.4	2	0.6	166	0.9	158	0.9	103	0.8	95	0.5	117	0.5	117	0.9	105	0.0	91	1.3	63
1927	0.4	15	1.0	30	-0.5	12	1.3	77	0.7	59	1.7	33	1.7	33	0.4	60	-0.6	38	0.6	19
1928	-0.4	35	0.4	161	1.7	100	1.7	89	2.1	78	2.5	82	2.5	82	1.3	101	1.0	153	0.8	30
1929	-	-	1.7	119	2.0	44	1.8	88	0.6	81	0.6	81	0.6	81	0.7	83	0.8	88	0.2	48
1930	-	-	0.7	100	0.8	90	0.6	103	0.4	94	-0.9	145	-0.9	145	0.9	104	0.8	117	0.5	17
1931	-1.3	15	-0.3	192	0.7	54	1.6	45	0.8	102	1.0	55	1.0	55	0.8	95	0.2	56	-0.6	15
1932	0.8	16	1.1	82	1.8	35	1.5	78	0.9	72	0.9	26	0.9	26	0.7	115	0.2	49	0.1	26
1933	-0.1	13	0.0	82	0.6	62	0.5	81	0.9	70	0.4	48	0.4	48	0.5	74	0.3	59	0.3	49
1934	-0.8	11	0.9	103	0.7	41	0.7	86	1.1	33	0.4	61	0.4	61	0.8	83	-0.2	46	1.5	43
1935	0.3	19	1.0	76	1.3	31	0.9	36	0.2	47	0.8	50	0.8	50	1.6	23	0.6	51	-0.3	16
1936	0.4	9	1.0	102	0.5	74	0.9	62	1.1	53	0.7	21	0.7	21	0.9	56	1.2	62	0.3	18
1937	0.5	12	0.0	78	0.3	93	0.4	92	0.4	79	0.0	49	0.0	49	0.0	39	0.3	78	0.9	68
1938	-	-	-0.9	91	-0.3	94	0.2	52	0.1	55	-0.7	49	-0.7	49	-1.0	41	-2.5	13	-0.9	73
1939	-1.4	8	0.7	99	0.5	59	-0.2	30	0.7	36	0.8	52	0.8	52	0.9	90	1.1	40	0.5	15

5
13
17
15
26
49
43
16
18
68
73
15

0.2
1.0
0.2
0.5
0.3
1.5
0.3
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0.9
0.5
0.7
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0.7
1.0
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0.9
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9
1
1
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1
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1
1
1
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1
1

A comparison of the graphs for the areas A and B shows that the variations of the temperature in the two areas are in accordance with one another to a high degree. Thus these variations may be taken as characteristic for large areas. It appears from the figure that for the years up to 1920 there is a steady change of positive and negative anomalies, whereas a very conspicuous rise of temperature sets in at the beginning of the Twenties. These high temperatures prevail during the remaining part of the period considered. The rather low temperatures for 1938 should, however, be noticed.

As it has already been mentioned, the rise of temperature is not limited to the areas at Greenland investigated here. It is, therefore, intended later on to take up a similar investigation for other areas in order to trace the geographical variation of the temperature increase.

Simultaneously with this rise of temperature of the surface water a considerable increase of the

air temperature has taken place in the regions considered. The higher sea temperatures are probably — through the exchange of heat between the atmosphere and the water — caused mainly by the increase of air temperature. And the latter may in its turn, as suggested by Scherhag (l. c.), be accounted for by the increased atmospheric circulation during the same years. For the areas considered here it is intended to treat these problems elsewhere.

Jens Smed.

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THE FISH

Faroes.

Haddock.

The table below sums up the position of size and age composition of the haddock stock in Faroe waters in August and September 1945. The 1933 year-class seems to be predominant as in the North Sea. The absence of 1+ haddock in three of the areas may be attributed to the use of the finer-meshed Iceland cod-end. The measurements of scales are taken by fish-measurers on commercial trawlers fishing at Faroe; and the scale determinations were carried out by Mr. Walfrid Main.

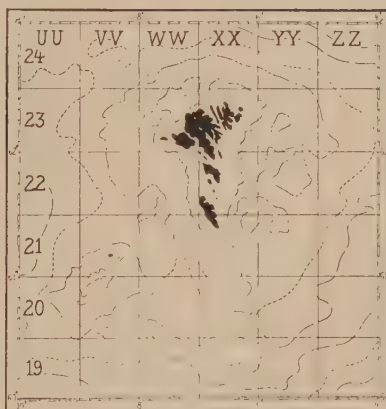


Fig. 3. Chart showing Areas.

Size and Age Composition of Haddock Stock — Faroe 1945.

Rectangle WW23 ¹⁾ 12 miles NW. from Myggenaes August 17-26				Rectangle YY23 10 miles E.x N. Fuglo August 21-23				Rectangle WW22 17 miles WNW. from Kolter August 26-31				Rectangle VV 23 12 miles W. of Myggenaes August-September			
Mean Size cm.	No. per 10 hrs.	per cent.		Mean Size cm.	No. per 10 hrs.	per cent.		Mean Size cm.	No. per 10 hrs.	per cent.		Mean Size cm.	No. per 10 hrs.	per cent.	
44	—	—	—	—	—	—	—	—	—	—	—	24.7	35	2.25	
43	36.7	307	52.30	37.2	333	47.24		35.9	2064	48.29		36.1	831	53.47	
42	47.3	86	14.65	47.3	87	12.34		47.9	305	7.14		46.1	266	17.12	
41	52.7	49	8.35	49.0	98	13.90		51.5	400	9.36		51.1	200	12.87	
40	57.8	67	11.42	54.7	66	9.36		55.6	477	11.16		56.9	79	5.08	
39	62.1	52	8.86	59.3	71	10.07		61.1	905	21.17		59.0	99	6.37	
38	66.3	24	4.08	61.8	47	6.66		70.8	68	1.59		66.3	34	2.19	
37	75.0	1	0.17	66.0	3	0.43		70.8	53	1.24		67.7	9	0.58	
36	81.0	1	0.17	—	—	—		74.5	2	0.05		81.0	1	0.07	
Total		587			705				4274				1554		

R. S. Clark.

¹⁾ see Fig. 3.

Trawler working in areas WW23, YY23 and WW22 was using Iceland cod-end.

Halibut.

Marking Experiments on 3—5-year-old Halibut in Faroese Waters.

No recaptures of small halibuts marked in Faroese fjords and bays in 1937—39¹⁾ have been obtained later than 1942, and it is therefore not likely that more recaptures will appear. The tab-

¹⁾ see "A.B." I, p. 80 and Journ. du Conseil, 13, 1938, pp. 370—375.

les below give a survey of the general results of these experiments.

The sizes of the marked specimens were lying between 35 and 81 cm.; the average size being 46 cm. The ultimate average size of the specimen which left the Faroe area was 64 cm. (the range of variants being 53—78 cm.).

Å. Vedel Tåning.

Experiment July—August 1937: 68 specimens liberated in the fjords.

Year	In the Fjords	on the Banks	Recaptures		Total
			at Iceland	in the North Sea	
1937	2	1	—	—	3
1938	5	5	4	1	15
1939	—	2	2	1	5
1940	—	—	1	—	1
Total	7	8	7	2	24 = 35.3 %

9 out of 24 have left the Faroe area, i.e., emigrants of recaptures: 37.5 %

Experiment August 1938: 24 specimens liberated in the fjords.

Year	In the Fjords	on the Banks	Recaptures		Total
			at Iceland	in the North Sea	
1938	1	—	—	—	1
1939	5	2	1	—	8
1940	1	—	2	—	3
1941	—	—	—	—	—
1942	—	—	1	—	1
Total	7	2	4	—	13 = 54.2 %

4 out of 13 have left the Faroe area, i.e., emigrants of recaptures: 30.8 %

Experiment July—August 1939: 137 spec. liberated in the fjords and on the banks.

Year	In the Fjords	on the Banks	Recaptures		Total
			at Iceland	in the North Sea	
1939	6	2	—	—	8
1940	—	2	1	—	3
1941	—	—	3	—	3
Total	6	4	4	—	14 = 10.2 %

3 out of 14 have left the Faroe area, i.e., emigrants of recaptures: 28.6 %

All Experiments: 229 specimens liberated.

Year	in the Fjords	on the Banks	Recaptures		Total
			at Iceland	in the North Sea	
1. year	9	3	—	—	12
2. year	10	9	6	1	26
3. year	1	2	8	1	12
4. year	—	—	—	—	—
5. year	—	—	1	—	1
Total	20	14	15	2	51 = 22.3 %

17 out of 51 have left the Faroe area, i.e., emigrants of recaptures: 33.3 %

Measurements.

From the Bill Bailey Bank, SW. of the Faroës, measurements taken by a fish-measurer on the Green Steam Liner "Vale of Clyde" have been made in July—August 1945. There were no opportunities to secure otoliths. Measurements of Halibut from the Rockall Bank have been included for comparison. The measurements are in 5-cm. groups.

R. S. Clark.

Measurements showing Frequencies.

	Bill Bailey Grounds 30.7—2.8 1945	Rockall Grounds 23.7—6.8 1945
198	—	1
175—176	—	1
170—174	—	1
165—169	—	1
160—164	—	4
155—159	—	1
150—154	—	4
145—149	2	3
140—144	1	1
135—139	1	8
130—134	1	8
125—129	—	10
120—124	1	18
115—119	—	13
110—114	—	4
105—109	3	8
100—104	9	10
95—99	15	10
90—94	42	12
85—89	77	1
80—84	63	4
75—79	59	—
70—74	35	1
65—69	11	—
60—64	3	—
59	1	—
Total	324	124

Lemon Sole.

Measurements and samples of scales of lemon soles were obtained from trawler catches at Faroe three occasions between August 1945 and February 1946.

The size frequencies in 5-cm. groups are given

in the following table which also gives the size frequencies of lemon soles caught by the Scottish research vessel at Faroe in June 1939 — captures in the small mesh covering the cod-end excluded.

Year		21—25	26—30	31—35	36—40	41—45	46—50	Total
1945—46	No.	15	150	426	525	166	6	1288
	%	1.2	11.6	33.1	40.7	12.9	0.5	
1939	No.	14	26	38	33	3	—	114
	%	12.3	22.8	33.3	28.9	2.7	—	

The age composition of both sets of records has been determined as follows:

Year		3+	4+	5+	6+	7+	8+	9+	10+	11+	12+	13+	14+	15+	Total
45—46	No.	1	15	6	39	12	41	36	28	13	5	6	3	1	206
	%	0.5	7.3	2.9	19.0	5.8	19.9	17.5	13.5	6.3	2.4	2.9	1.5	0.5	
39	No.	1	10	34	9	8	10	14	9	5	10	3	1	—	114
	%	0.9	8.8	29.8	7.9	7.0	8.8	12.3	7.9	4.3	8.8	2.6	0.9	—	

B. B. Rae.

Atlantic Slope.

INTRODUCTION.

Le secteur du Plateau Continental Atlantique fut pendant cinq ans un secteur de guerre dans lequel les recherches océanographiques durent complètement interrompues. De multiples difficultés ont retardé leur reprise. Les rapports communiqués ne relateront donc pas les résultats d'observations récentes dans le domaine de l'océanographie physique ou la biologie marine. D'autre part, les résultats des observations antérieures aux hostilités ont fait l'objet d'études et de rapports qui ont déjà été publiés dans les différents pays membres du Conseil.

Les rapports de:

Marine Biological Association, Plymouth, sur la teneur en phosphates et en nitrates en surface et en profondeur dans la Baie de Plymouth,

C. F. Hickling sur le haddock du banc Porcupine; le rétablissement de la pêcherie du merlu au SW. des Iles Britanniques; les pêcheries de hareng à Milford Haven,

G. P. Farran sur la taille et l'âge des harengs de la côte d'Irlande; les croisières irlandaises en 1938—1939; les pêcheries de maquereaux ayant conservé leur caractère d'originalité trouveront seuls leur place ici.

J. le Gall.

ENVIRONMENT.

The Phosphate and Nitrate Contents of the Surface and Deeper Water off Plymouth, 1938 to 1945.

mmg.-atom per m.³, Phosphate-P corrected for Salt Error.

	Depth in Metres at International Station E ₁						
	0	5	10	15	25	50	70
1938, Sept. 20	0.04	0.02	—	0.06	0.17	0.23	0.23
" Oct. 24	0.33	0.34	0.34	0.33	—	0.33	—
" Nov. 29	0.45	0.37	—	0.39	0.38	0.38	0.38
1939, Jan. 10	0.52	0.51	—	—	0.51	0.47	0.48
" Feb. 6	0.52	0.51	—	0.53	0.53	0.54	0.52
" Mar. 13	0.39	0.39	—	0.39	0.39	0.40	0.40
" April 19	0.06	0.00	—	0.04	0.19	0.22	0.23
" May 11	0.45	0.01	—	0.02	0.22	0.22	0.22
" July 5	0.02	0.05	—	0.05	0.06	0.20	0.21
" Aug. 14	0.10	0.05	—	0.06	0.27	0.24	0.26

Date	Position	Range of Depth sampled	mmg.-atom pr. m. ³ Phosphate-P and Nitrate N	
			P	N
1939, Dec. 31	50°02'N.; 4°22'W.	surf.	0.42	—
1940, Jan. 15	"	"	0.42	—
" " " "	"	"	0.32	—
" " " "	"	"	0.59	—
" Feb. 1	50°06'N.; 4°20'W.	"	0.58	—
" " " "	50°02'N.; 4°22'W.	"	0.35	—
" " " "	"	"	0.37	—
" Feb. 6	50°06'N.; 4°20'W.	"	0.52	—
1942, Jan. 7	50°06'N.; 4°15'W.	0—8 m.	0.44	—
1943, Jan. 6	50°10'N.; 4°16'W.	"	0.42	—
" Jan. 13	50°13'N.; 4°17'W.	"	0.40	—
1944, Jan. 6	50°05'N.; 4°13'W.	"	0.45	—
" Jan. 20	"	"	0.44	—
1945, Jan. 9	"	"	0.46	—

Marine Biological Association, Plymouth.

THE FISH.

dock.

Haddock on the Porcupine Bank.

The Porcupine Bank had a complete rest from fishing from December, 1940, to August, 1944. When fishing was resumed, the Bank was found to carry a population of haddock five times as large as in the previous best year. These haddock were found to belong to two year-classes, those of 1938 and 1942. The rate of growth of these Porcupine haddock was, during the first four years of their life, the fastest of any haddock stock yet investigated. Later years, however, the rate of growth fell below that of Iceland and Faroe haddock. The Porcupine fish reached an average length of 43 cm. at the end of their third, and 51 cm. at the end of their fourth year of life. The number of sclerites in the first two annual rings is also the largest in any stock so far investigated.

The rate of growth of the 1942 year-class was less than that of the 1938 year-class, suggesting that, in this stock, a much denser population of fish had no effect in slowing the rate of growth.

C. F. Hickling.

ke.

The Recovery of the Hake Fishery of the South-Western Area.

The fishing capacity of a steam trawler increases in direct proportion as the gross tonnage increases. Therefore, the fishing capacity of a fleet of steam trawlers will increase or decrease in direct proportion to the aggregate gross tonnage, and it is estimated that the total fishing capacity of the fleet based on Milford Haven declined, as a result of naval requisitioning, in 1940, to 58 % of that of the immediate pre-war years, and in 1941 to 1944 to 10 %.

The statistics show that, in the early years of the fishery at Milford Haven, the yield of fish in-

creased in direct proportion to the increase in the aggregate gross tonnage of the fleet, but that, when the fleet had reached a size of about 18,000 gross tons, further increases resulted in only a slight increase in the total weight of fish landed. Indeed, at these high levels of fishing intensity, there is an inverse correlation between the fishing effort and the yield of fish per unit of fishing effort.

The first effect, therefore, of the war-time reduction in the size of the fishing fleet, and so of the fishing effort, was an increase in the yield of fish per unit of fishing effort. But, in the later war years, the increase went far beyond this, and was almost entirely due to a spectacular increase in the abundance of large and medium sized hake.

In most of the years between the two world wars, too intensive fishing was leading to the fishing out of the larger hake at a rate of decrease of about 15 %, the mortality rate being estimated at about 46 %. Since the war-time requisitioning of the fishing fleets, the mortality rate is estimated at 21 %. Consequently, in the years 1942—1944, a fishing fleet reduced to an aggregate of between 8,000 and 9,000 gross tons landed annually a greater weight of hake than was landed, between the wars, by a fleet aggregating from 20,000 to 30,000 gross tons. The recovery of the fishing grounds was complete.

C. F. Hickling.

Herring.

England.

The Herring Fisheries at Milford Haven.

A survey of the statistics of the drift and trawl fisheries at Milford Haven suggests that the drift-net fisheries in the winter and spring, and the trawl fishery in the summer, are based on the same stock of herrings. It is possible to estimate the prospects for the summer trawl herring season from the yield of herrings in the previous winter drift-herring season.

C. F. Hickling.

Eire.

Herring Samples from the Coasts of Eire 1939—45.

Size Distribution (%) in cm.

	Fish examined	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
N.-W. Coast (Donegal Bay)																
1939, Jan.	165	—	—	—	—	—	—	—	3	16	14	12	9	21	19	—
1940, Jan.	147	—	—	—	—	—	—	3	4	8	16	28	21	12	3	—
1944, March	94	—	—	—	—	—	—	—	—	1	6	35	18	28	11	—
1945, Nov.—Dec.	221	—	—	—	—	—	—	—	2	6	12	34	36	7	1	—
W. Coast (W. Galway [Cleggan])																
1943 Sept.	58	—	—	—	—	—	—	4	1	7	17	36	24	6	4	—
W. Coast (Galway Bay)																
1940, Nov.—Dec.	173	—	—	—	—	—	1	7	8	21	33	26	6	—	—	—
1943, Octob.	121	—	—	—	—	2	2	9	11	15	19	33	7	2	—	—
S. Coast (Kinsale)																
1943, Nov.	161	—	—	—	—	—	1	6	6	10	15	9	3	—	—	—
1944, Sept.—Octob.	243	—	—	—	—	—	2	5	13	19	33	22	5	—	—	—
S.-E. Coast (Waterford)																
1943, Jan.	212	—	—	—	—	1	—	5	11	16	12	4	—	—	—	—
1944, Jan. + (1943, Dec.)	317	—	—	1	2	3	4	4	12	17	30	21	5	1	—	—
E. Coast (Howth)																
1939, July	276	2	14	24	16	13	6	14	7	3	—	—	—	—	—	—
1943, July	208	3	9	27	20	13	8	10	9	—	—	—	—	—	—	—
1944, July—Aug.	286	—	1	3	8	27	33	14	10	2	1	—	—	—	—	—
1945, Aug.	203	—	—	1	20	31	25	16	6	1	—	—	—	—	—	—

Age-Composition (%).

	2	3	4	5	6	7	8	9	10	11	12	13	14
Winter rings:													
N.-W. Coast (Donegal Bay)													
1939, Jan.	—	—	41	7	10	9	14	4	4	5	2	4	1
1940, Jan.	—	14	7	67	1	2	4	2	—	1	1	—	—
1944, March	—	—	2	39	18	14	20	5	2	2	—	—	—
1945, Nov.—Dec.	4	5	8	10	38	16	10	8	1	—	—	—	—
W. Coast (W. Galway [Cleggan])													
1943, Sept.	3	9	34	21	23	7	1	—	—	—	—	—	—
W. Coast (Galway Bay)													
1940, Nov.—Dec.	16	19	36	21	6	1	—	—	—	—	—	—	—
1943, Octob.	24	7	39	15	4	5	3	2	—	—	—	—	—
S. Coast (Kinsale)													
1943, Nov.	4	15	20	12	13	19	8	5	2	1	—	—	—
1944, Sept.—Octob.	2	12	16	17	11	13	12	9	5	2	—	—	—
S.-E. Coast (Waterford)													
1943, Jan.	—	2	6	22	15	24	21	4	4	1	1	—	—
1944, Jan. + (1943, Dec.)	—	12	12	17	9	10	11	15	6	5	—	—	—
E. Coast (Howth)													
1939, July	54	21	11	5	6	2	1	—	—	—	—	—	—
1943, July	74	8	16	2	—	—	—	—	—	—	—	—	—
1944, July—Aug.	60	27	9	3	—	—	—	—	—	—	—	—	—
1945, Aug.	66	19	10	3	2	—	1	—	—	—	—	—	—

Where more than one sample has been investigated during one season of a year the average of the percentage distribution of each sample has been given.

G. P. Farran.

kerel.

Irish Cruises 1938 and 1939.

The cruises in the mackerel spawning area were arranged in collaboration with the English and French representatives at the meeting of the Mackerel Sub-Committee held at Plymouth on 9th December, 1937 were carried out by the Trawler "Muirchu" on April, 7th—12th, 1938, and April, 17th—21st, 1939. Collections were made with a 2 metre stramin ring-net hauled usually from 70 fathoms (127 m.) to the surface, haul lasting 30 minutes. Vertical hauls with 1 m. medium silk tow-net and temperature and salinity observations were also made. The fish and larvae taken in the 2 m. ring-net were identified at the Marine Biological Laboratory, Plymouth by Mr. G. A. Steven and Mr. P. G. Whelan by the courtesy of the Director, the late S. W. Kemp.

The accompanying charts, Figs. 1 and 2, show the positions of the stations in 1938 and 1939 respectively and the densities of mackerel eggs found on, also the approximate positions of the surface isotherms and isohalines. The catch of mackerel eggs at each station is shown as distributed over

a circle of twelve miles in diameter, each dot representing 100 mackerel eggs. The intermediate spaces are filled in with interpolated dots.

The latitude and longitude of the stations and the actual or estimated numbers of mackerel ova and larvae and of some other organisms found on each station are given in the accompanying table (see p. 32). Notable concentrations of other organisms not included in the table were, in 1938, *Limacina* — S. R. 2888, 77,000 (constituting about two-thirds of the whole gathering); S. R. 2891, 20,000; S. R. 2893, 16,000. *Sagitta*, mainly *S. elegans* — S. R. 2875, 8,200; S. R. 2881, 2,250; and in 1939, *Limacina* — S. R. 2934, 28,000; *Sagitta*, mainly *S. elegans* — S. R. 2918, 7,500; S. R. 2919, 3,000; S. R. 2933, 1,100. Larval decapods of various species were plentiful over the whole area.

From the isolated occurrence of shoals or concentrations of mackerel ova or other organisms in this area it seems evident that a distance of twenty miles between the various stations is too great to allow of an entirely reliable picture of the detailed distribution of the plankton being formed.

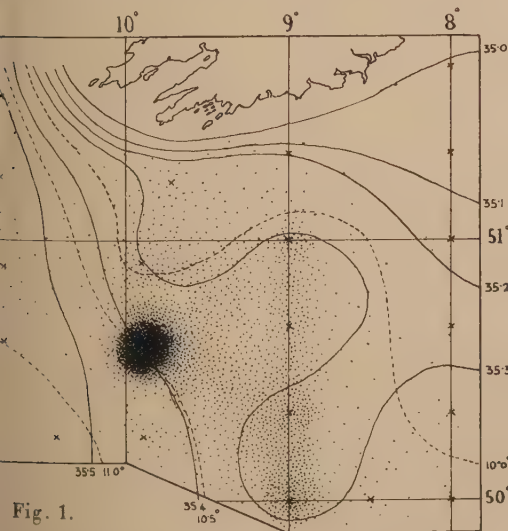


Fig. 1.

1. Chart of Distribution of Mackerel Ova taken in 2 m. ring-net on April 7th—12th, 1938, showing surface isotherms and isohalines. Each dot represents 100 ova, X Positions of stations.

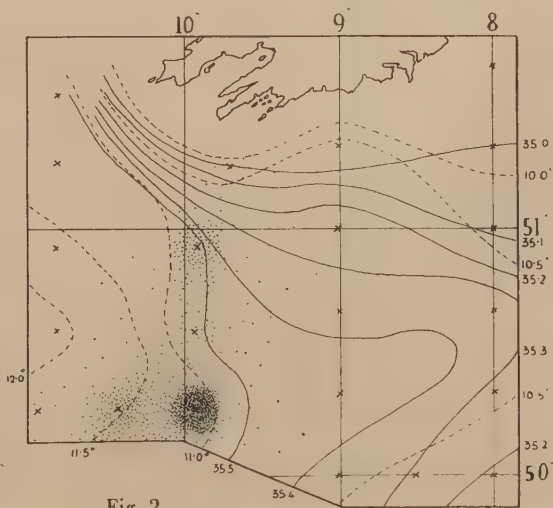


Fig. 2.

Fig. 2. Chart of Distribution of Mackerel Ova taken in 2 m. ring-net on April 17th—21st, 1939, showing surface isotherms and isohalines. Each dot represents 100 ova, X Positions of stations.

Position	Stat. No. SR.	Date	Ova		Larvae		Calanus	Metridia	Candacia armata
			Macke- rel	Total Fish	Macke- rel	Total Fish			
51°40'N.; 8°00'W.	2872	7-IV-38	0	1100	0	25	352	0	0
	2913	17-IV-39	0	908	0	114	4466	1298	0
51°20'N.; 8°00'W.	2873	7-IV-38	50	4730	0	73	4200	170	0
	2914	18-IV-39	0	609	0	24	29136	5400	0
51°00'N.; 8°00'W.	2874	5-IV-38	25	335	0	42	3270	285	0
	2915	18-IV-39	0	34	0	1	22300	498	0
50°40'N.; 8°00'W.	2875	8-IV-38	81	99	0	5	5200	215	0
	2916	18-IV-39	0	30	0	2	3000	17	0
50°20'N.; 8°00'W.	2876	8-IV-38	461	468	0	1	5200	1	0
	2917	18-IV-39	0	4	0	4	6086	5720	0
50°00'N.; 8°00'W.	2877	8-IV-38	138	153	0	4	2344	16	0
	2918	19-IV-39	0	10	0	16	4110	1075	0
50°00'N.; 8°30'W.	2878	8-IV-38	1220	1250	0	0	1650	3	0
50°00'N.; 8°32'W.	2919	19-IV-39	13	21	0	1	8800	1500	0
50°00'N.; 9°00'W.	2879	8-IV-38	15380	15480	0	1	3368	16	0
	2920	19-IV-39	88	234	0	0	224	16	0
50°20'N.; 9°00'W.	2880	8-IV-38	13350	13360	0	0	1360	12	0
	2921	19-IV-39	54	151	0	0	1232	16	0
50°40'N.; 9°00'W.	2881	8-IV-38	8130	8200	0	0	2682	560	1
	2922	19-IV-39	9	32	0	0	900	100	0
51°00'N.; 9°00'W.	2882	9-IV-38	8380	9056	0	11	4060	910	0
	2923	19-IV-39	28	113	0	0	136	17	0
51°20'N.; 9°00'W.	2883	9-IV-38	487	1005	0	219	7255	3200	0
	2924	19-IV-39	23	321	0	245	8300	170	0
51°14'N.; 9°43'W.	2884	9-IV-38	1850	1980	0	5	1068	52	0
51°14'N.; 9°42'W.	2925	19-IV-39	694	870	0	52	11350	910	0
50°36'N.; 9°55'W.	2885	11-IV-38	6180	6300	0	4	1368	152	0
	2926	20-IV-39	9570	10800	0	343	2930	1120	152
50°36'N.; 9°55'W.	2886	11-IV-38	96080	100440	16	23	5400	130	0
	2927	20-IV-39	4132	4207	11	104	1500	50	18
50°16'N.; 9°55'W.	2887	11-IV-38	2730	3760	0	18	3720	1	2
	2928	20-IV-39	33000	33300	120	168	560	13	0
50°16'N.; 10°26'W.	2888	11-IV-38	126	326	9	365	210	40	15
	2929	20-IV-39	11700	12000	95	123	380	0	4
50°16'N.; 10°57'W.	2889	11-IV-38	0	414	2	75	45	560	5
	2930	20-IV-39	1092	2130	13	153	33	6	34
50°36'N.; 10°48'W.	2890	12-IV-38	780	2227	0	16	120	1960	160
	2931	20-IV-39	480	521	73	457	152	1152	294
50°56'N.; 10°48'W.	2891	12-IV-38	780	1520	6	76	63	28	7
	2932	20-IV-39	14	20	6	500	415	2124	2880
51°16'N.; 10°48'W.	2892	12-IV-38	321	551	17	137	870	84	0
	2933	21-IV-39	5	40	41	3300	1180	2200	3160
51°33'N.; 10°45'W.	2893	12-IV-38	136	166	0	3	7177	75	1
51°33'N.; 10°48'W.	2934	21-IV-39	10	131	10	4300	11000	3360	4000

Northern North Sea.

INTRODUCTION

THE Scottish research vessels operated in the area from March to August 1939 and as the results have not been published, the following summary may be useful for comparison with observations for the same year which have appeared in Volume I of this series.

A preliminary abbreviated account of a successful transplantation experiment covering the period 1937 to 1940 has also been included. Fishing and transportation of the fish were carried out by the research vessel "Explorer".

During the war scientific investigations were at a standstill though attempts were made, as for example in England, to continue fish-measuring on commercial landings. With the cessation of hostilities in 1945 renewed efforts were made to obtain first hand information as to the abundance, size and age composition of the stocks of the more important commercial food fishes. The Scottish Home Department, which had maintained the nucleus of a laboratory in temporary quarters at Aberdeen, initiated such a scheme and a team of fish-measurers was employed from July 1945 onwards to go to work on board commercial trawlers and measure scale representative samples of fish. Efforts were concentrated largely on haddock which has been Scotland's chief demersal species, but cod, whiting and lemon sole were also investigated.

The pelagic fisheries also received attention and representative samples of the Scottish summer fishery were taken from the landings at Fraserburgh and Aberdeen and were measured and scaled.

Some experimental work in association with the Ministry of Agriculture and Fisheries was carried out off Lowestoft and in the Clyde estuary, with the help of the Admiralty, to test the possibility of using Asdic for the location of herring shoals.

Except for some war-time measurements by England on cod, haddock and whiting, some observations on trawled herring by Denmark and Sweden, and the present data by Scotland, there were no contributions from the other countries represented on the Committee.

Scottish Investigations in 1939.

The Scottish research vessels operated as in previous years from March until August but work ceased on the outbreak of war. The main results were as follows:—

Hydrography: The first observation for the year, in March, in the north-western area of the North Sea, showed the normal spring oceanic influx to be about its climax, although not apparently of abnormal intensity since it clearly waned during April until, in May, sub-normal conditions obtained in the middle North Sea area. A return to normal conditions was evident by July and a month later it was obvious that the oceanic incursion from the north was approaching a second maximum for the year, when temperatures and salinities were appreciably above average over almost the entire northern North Sea.

As a result of this secondary incursion, a reversal of the normal southerly drift on the western side of the North Sea took place from Spurn Head to Shetland.

Plankton: Plankton distributions in the northern and middle North Sea followed generally the disposition of the several water-masses. The weak spring oceanic influx was reflected in a poverty of oceanic plankton species, while young Calanus were common and large numbers of other Copepods, notably Pseudocalanus, were encountered over a wide area.

Sagitta elegans occurred to the northward and *S. setosa* to the south of a line from the Northumberland coast to Jutland.

The autumn influx of Atlantic water was scarcely evident in the few plankton species taken in the northern area in August, although *Limacina* had penetrated there in considerable numbers.

In June in the Faroe-Shetland Channel, typical oceanic species such as Salps, *Doliolum tritonis*, *Paralepis*, *Fierasfer*, and *Scopelids*, were observed in the warm tongue of water extending in mid-Channel northwards to latitude 61°N.

Towards Faroe a southerly-directed branch of cold boreal water was rich in Calanus. On the Continental Edge, Atlantic types such as *Doliolum gegenbauri* and *Agalmopsis* occurred in the stretch from off the Hebrides to north of Shetland. A mixed Atlantic fauna containing *Limacina* and *Sagitta elegans*, was noted on the Continental Shelf west of Orkney and in the Minch.

West Scottish coastal plankton was very rich in adult Calani.

Bottom Fauna: The study of bottom living food animals was continued with a view to assess supplies available for commercial fishes. Prawns and shrimps in coastal waters were assessed as regards species, numbers, breeding, and rate of growth. The common shrimp inhabiting shallow coastal waters is an important item in the food of plaice, cod, and haddock. A deeper water species is sought by most fishes, particularly haddock, in the autumn months.

Haddock: The position of the North Sea stock in 1939 was similar to that of 1938. The originally prolific 1935 brood, now in its fifth year and consequently not expected to bulk large in the 1939 catches, was however more abundant than was anticipated. The numbers of older haddock were negligible. The broods of 1936 and 1937 were inferior in their recruitment and did not contribute much to the commercial landings. The 1938 brood in the hauls of the research vessel was more numerous than was estimated at the end of that year, approximating in strength to that of the 1933 year-class rated at 2.5 on the basis of 10 for the prolific 1923 brood. The area of densest concentration of the 1938 brood was in the deeper area of the central North Sea, the area of slowest growth rate.

Sampling of the independent stock at Faroe showed a high percentage of the 1938 year-class.

Plaice: New recruitment to the plaice stock on the east Scottish coast was considerable in Aberdeen Bay and in the Moray Firth. The intensity of seine net fishing in Aberdeen Bay had an adverse effect on older year-classes, particularly that of 1937, the average catch per boat being the lowest for several years. Moray Firth catches were about the average for the last ten years.

Lack of observations in the autumn precluded an estimate being made of new recruitment to

plaice stocks south of Aberdeen. St. Andrews yielded the poorest fishery for many years, a circumstance which is probably to be accounted by two successive years of poor recruitment, namely 1936 and 1937.

Older year-classes were better represented the Firth of Forth than has been the case some time.

Marking experiments yielded a return of 30 during the year, unusual movements being recorded in the Orkney-Shetland region. Some east Orkney liberations for instance were recovered in Moray Firth, while liberations in North Sound were recaptured in Shetland waters and in the north and north-west coast of the Scottish mainland. Some plaice caught and liberated at St. Kilda were recaptured near the Flannan Islands.

Lemon Soles: The food of lemon soles requires further attention. A definite break in feeding occurs in winter, particularly in December, when April to September appears to be the most active feeding period for this species. As this coincides largely with the spawning period, this feature is at variance with the evidence in respect of many other fishes. Polychaete worms are the principal items of diet, although Crustacea, Molluscs, and Echinoderms are also of importance. In 1939, 1933 and 1934 year-classes predominated in the catches, while that of 1935 occurred in numbers in inshore areas.

Herring Larvae: Sea investigations were not continued long enough to define the spawning localities of the autumn herring, or the abundance and distribution of the larvae. Spring conditions, however, were determined for the greater part of the Scottish area. The localities of origin of spring larvae were (1) the Firth of Forth, (2) the Norwegian west and south-west coasts, (3) Viki Bank, (4) north-west and north of Shetland, and (5) the north and west coasts of Scotland, including the Minch.

Enormous numbers of newly-hatched stages occurred north of Shetland in March and considerable spawning was evident in the Viking area. The Firth of Forth and Norwegian coast areas were the only other localities where spring larvae were encountered.

To the east of Faroe indications were that hatching had already taken place in these waters, some larvae were taken in June well offshore.

Hatching on a large scale had taken place on the offshore grounds, as well as on the inshore grounds, to the west and north of Scotland. This area was not investigated till May month when the larvae at varying stages of development were found in great abundance practically throughout the area from Stanton Bank northwards. Exceptionally large numbers were again observed in the Kilda region. The larvae were dispersed along the whole coastline as far out as the edge of the continental shelf.

al slope. Obviously the drift of the passive was in agreement with the movement of water masses, i.e. north-easterly in western dean waters, and easterly and north-easterly the north Scottish mainland. The larger on the Dubh Artach and adjacent grounds ated an immigration of larvae originating from ning grounds on the Irish coast. The high ction of larvae so far offshore on the west of Scotland is being examined more closely w of the movements and concentration of the shoals and the relation of the oceanic type rring to the estuarine type of spring spawner, i occurs in the Clyde estuary.

ng: Two year-classes, those of 1933 and , predominated in the winter shoals of the of Forth, forming 80 % of the samples ex- ed. Three-year-old fish were scarce and there no evidence of new recruitment to the shoals. n the Scottish east coast, young spring fish scarce, but autumn fish, three and five years ge, accounted for 85 % and 90 % respectively am- ples examined. The late autumn spawners e five-year-old group left the grounds during after August. There was no evidence of a e spawning concentration, shoals consisting

mostly of young fish, although considerable num- bers of spents were taken on the Fladen ground in October and November.

At Shetland the fishery was poor owing to the scarcity of young spring and autumn fish. The shoals were mixed until July when the usual sharp decline took place. Spring fish disappeared and the fishery became dependent on autumn herring. The shoals dispersed after spawning, probably to the north and north-west.

The west coast herring fishery, usually erratic, consisted mainly of spring fish. In the Clyde area, four-year-olds (1935 year-class) comprised 90 % of the samples. There was evidence of good re- cuitment from estuarine stock.

In the Stornoway area two-year-old fish were prominent in July.

Lobsters: Lobster measurements were continued at six selected stations representative of the east, north and west coasts. Catch effort was deter- mined per number of creels and per fishing time. The position of the stock on the west and north coasts appears to have remained practically stable over a period of years. The large increase, how- ever, in small-sized lobsters which has been ob- served since 1936 was again evident at Burnmouth.

R. S. Clark.

THE FISH.

Haddock — 1945.

ish-measuring at sea commercial trawlers ating from Aberdeen been going on regular- nce July 1945. Tables d 2 give a typical pic- of the haddock stock he east coast of Scot- during the first three hs of the observations. year-class 1943 is out- ding while the origin- successful brood of is still well repre- ed.

Age for age, the mean are higher in post-war in pre-war haddock. The catch per ten hours ove in average.

The figure gives a gra- illustration of the pre- post-war condition of haddock stock and in- tes the beneficial effect e wartime reduction in ng effort.

Commercial Otter Trawl: Pre- and Post-War Sizes.
Summation Curve per 1000 Fish.

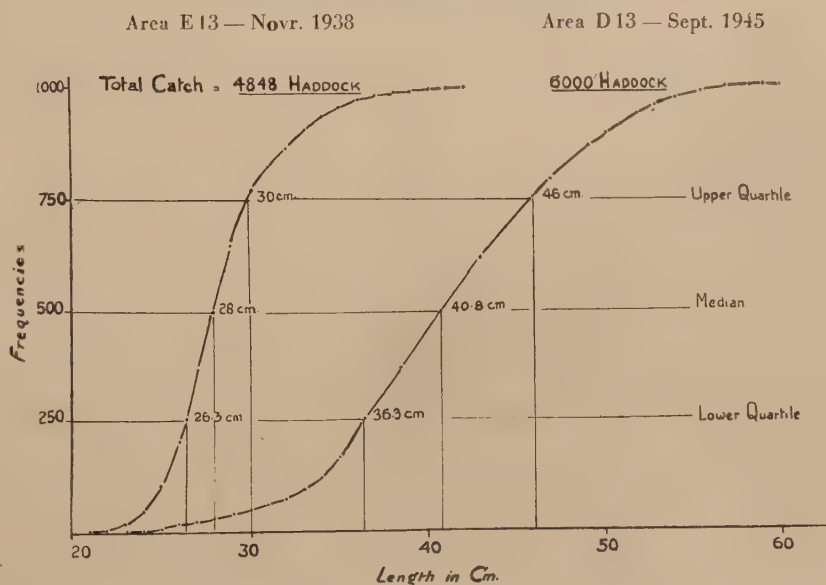


Table 1.
Size and Age Composition of Haddock
Stock in 1945.

Locality: Rectangle D12 — East of Montrose
Lat. 56°30' to 57°N. Long. 0° to 1°W.

Year Class	July			August		
	Mean Size in cm.	Number per 10 Hours	Per Cent	Mean Size in cm.	Number per 10 Hours	Per Cent
1944	24.4	791	21.00	24.7	1615	47.69
1943	34.7	1641	43.56	35.5	934	27.60
1942	40.8	588	15.61	41.8	322	9.52
1941	41.7	154	4.09	44.3	160	4.73
1940	44.7	150	3.98	46.9	108	3.19
1939	46.1	78	2.07	46.7	41	1.21
1938	47.4	356	9.45	48.2	202	5.97
1937	50.5	6	0.16	48.0	1	0.03
1936	55.0	2	0.05	47.0	2	0.06
1935	53.0	1	0.03	—	—	—

September

Year Class	Mean Size in cm.	Number per 10 Hours	Per Cent
1944	24.7	625	30.40
1943	35.1	581	28.26
1942	39.7	398	19.36
1941	43.3	81	3.94
1940	44.1	86	4.18
1939	45.5	54	2.63
1938	49.0	230	11.19
1937	—	—	—
1936	54.0	1	0.05
1935	—	—	—

Table 2.
Size and Age Composition of Haddock
Stock in 1945.

Locality: Rectangle D13 — East of Aberdeen
Lat. 57° to 57°30'N. Long. 0° to 1°W.

Year Class	July			August		
	Mean Size in cm.	Number per 10 hours	Per cent	Mean Size in cm.	Number per 10 hours	Percent
1944	24.7	48	3.34	27.4	57	2.0
1943	35.1	587	40.82	36.2	1028	36.4
1942	41.5	312	21.70	43.2	605	21.4
1941	44.9	174	12.10	44.8	367	13.0
1940	47.2	87	6.05	49.4	162	5.7
1939	48.3	58	4.03	49.6	73	2.5
1938	50.9	165	11.47	52.3	532	18.8
1937	54.3	6	0.42	—	—	—
1936	56.0	1	0.07	—	—	—

September

Year-Class	Mean Size in cm.	Number per 10 hours	Per Cent
1944	27.4	331	5.52
1943	36.8	2410	40.17
1942	43.2	1491	24.85
1941	47.6	497	8.28
1940	48.3	405	6.75
1939	48.8	235	3.92
1938	50.5	628	10.47
1937	53.0	1	0.02
1936	50.5	2	0.03

R. S. Clark.

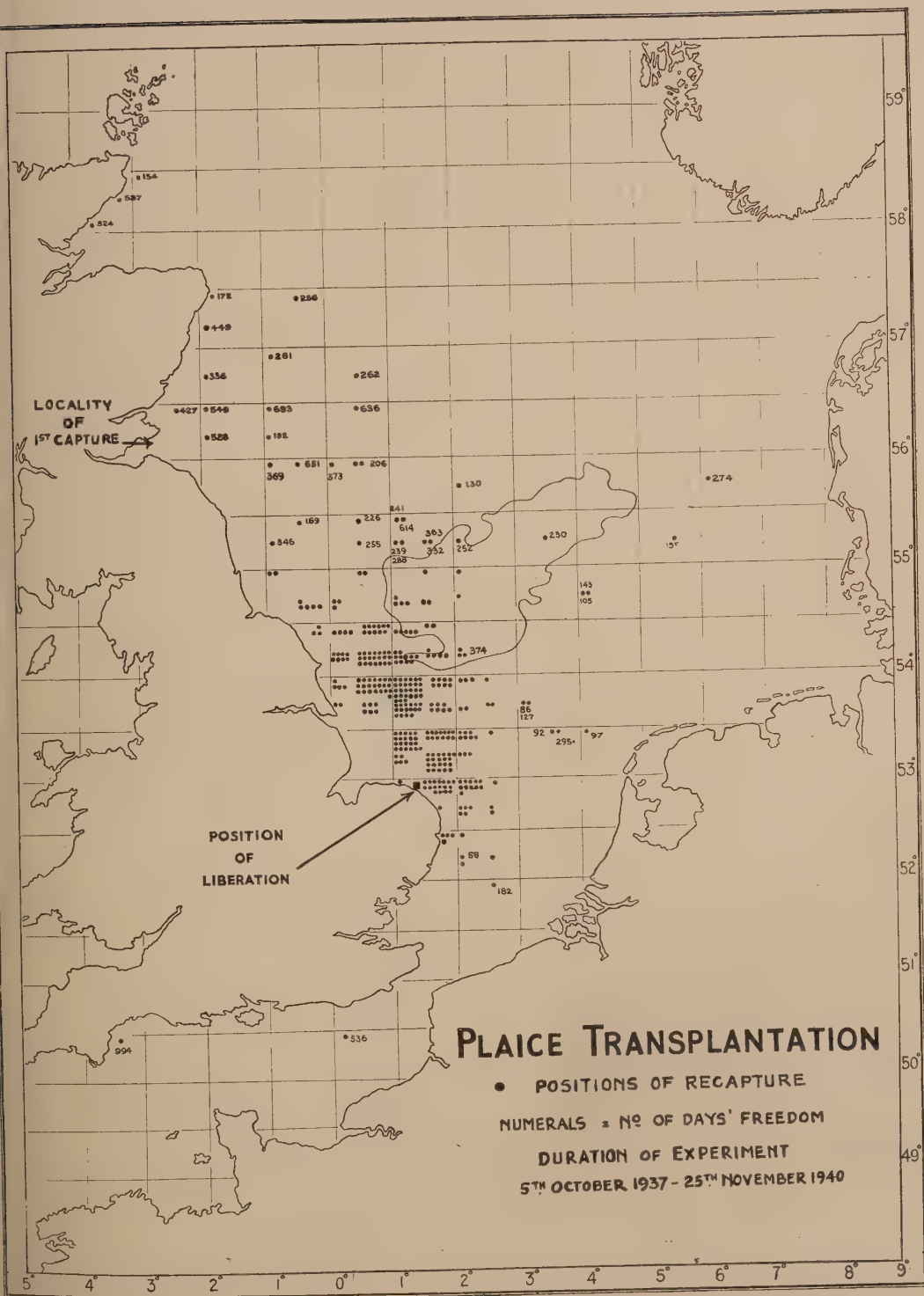


Figure 1.

Plaice Transplantation 1937—1940.

This is one of several experiments to determine the behaviour of fish preparing to spawn for the first time.

Locality of first capture — Largo Bay, Firth of Forth.
Position of liberation — $3\frac{1}{2}$ miles W. by N. of Haisboro Lightvessel.
Date of liberation — 5th October, 1937.
Number liberated 637 — Total number recaptured — 363.

Size-Frequencies of Liberated Fish.

Cm.	24	25	26	27	28	29	30	31	32	33	
M.	2	8	19	23	29	30	22	27	17	25	
F.	—	7	14	19	24	26	20	29	28	19	
Cm.	34	35	36	37	38	39	40	41	42	43	44
M.	20	20	13	19	16	13	4	2	1	2	—
F.	20	15	14	15	17	13	7	7	5	5	3
Cm.	45	46	47	48	49	50	51	52	Totals		
M.	3	—	—	1	—	—	—	—	316		
F.	6	3	1	1	—	1	1	1	321		

Percentage Recaptures.

1st Year	2nd Year	3rd Year	4th Year
ca. 50	7	+	+

Date of last recovery — 24th November.
Of the fish recaptured 91 % were taken in the trawl; 72 % were landed at Grimsby and Lowestoft.

The data provide evidence that marking, possibly also transplantation adversely affected the normal growth cycle for several weeks after liberation.

The recaptured fish ranged from two to ten years of age with the majority three to five years old.

Figure 1: A general scattering of fish from the liberation point is indicated with a finite tendency for the majority to proceed in a northerly direction. A few fish returned to Scottish waters but apart from the large number of migrants, i.e., fish recaptured near the position of liberation, the major recaptures were made off the Yorkshire coast. A few fish had moved to the Dogger Bank but no recaptures were made in the chief spawning area in the deep Sea Bight.

The dots indicate the statistical area in which recapture was effected or, in the case of distant migrants, the actual reported position of recapture. The figures alongside the latter group indicate the number of days' freedom.

R. S. C.

Lemon Sole — 1945.

Measurements and collection of scales of lemon soles caught by commercial trawlers fishing out of Aberdeen were commenced in July, 1945. Table 3 gives the size frequencies in 5 cm. groups up to the end of the year.

For comparison, the size frequencies of lemon soles caught by the research vessel, on grounds fished by commercial trawlers, during 1938 and 1939, are given in Table 4. Fish retained in the small mesh covering the cod-end have been disregarded.

While there is no doubt that the remarkable increase in the average size of the lemon soles comprising the post-war stocks is due, in some measure,

to the protection of the fishing grounds during the hostilities, age analysis shows that the failure of certain age-groups (e.g. 4+ and 5+) which normally supply the smaller trade categories i.e. 25 to 35 cm., has also played a part in bringing about the present position. Age composition of post-war stocks is shown in Table 5.

In contrast to this, the bulk of the stock in 1938 and 1939 was composed of fish of 4+ and 6+ years of age, a feature which was reflected in the preponderance of lemon soles belonging to the "small" category in the commercial catches of these years.

**Table 3. Size Frequencies July to December (incl). 1945.
Commercial.**

Locality	21—25 cm.	26—30 cm.	31—35 cm.	36—40 cm.	41—45 cm.	46—50 cm.	Total
South of Ratray Head	5	19	241	951	406	13	1635
%	0.3	1.2	14.8	58.1	24.8	0.8	
E. and N.E. of Moray Firth	7	33	86	125	23	—	274
%	2.6	12.0	31.4	45.6	8.4	—	
Fair Isle etc.	15	70	96	56	20	—	257
%	5.8	27.2	37.4	21.8	7.8	—	

**Table 4. Size Frequencies 1938—39.
Research Vessel "Explorer".**

Locality	21—25 cm.	26—30 cm.	31—35 cm.	36—40 cm.	41—45 cm.	46—50 cm.	Total
South of Ratray Head and Moray Firth	171	137	65	24	2	—	399
%	42.8	34.3	16.3	6.0	0.5	—	
Northern and Western Grounds	307	200	62	17	—	—	586
%	52.4	34.1	10.6	2.9	—	—	

Table 5. Age Composition of Post-War Lemon Soles.

Locality	3+	4+	5+	6+	7+	8+	9+	10+
South of Ratray Head	1942	1941	1940	1939	1938	1937	1936	1935
%	—	1	9	71	108	96	243	73
	—	0.1	1.2	9.6	14.6	13.0	32.8	9.8
Outer Moray Firth	1	12	10	33	39	36	49	29
%	0.5	5.3	4.4	14.6	17.2	15.9	21.7	12.8
Fair Isle etc.	4	13	14	60	43	22	46	29
%	1.6	5.1	5.5	23.6	16.9	8.7	18.1	11.4
Locality	11+	12+	13+	14+	15+	16+	Total	
South of Ratray Head	1934	1933	1932	1931	1930	1929		
%	73	51	8	6	2	1	742	
	9.8	6.9	1.1	0.8	0.2	0.1		
Outer Moray Firth	7	9	—	—	1	—	226	
%	3.1	4.0	—	—	0.5	—		
Fair Isle etc.	8	13	—	1	1	—	254	
%	3.2	5.1	—	0.4	0.4	—		

B. B. Rae.

Herring — 1945.

Table 1.
Herring Samples caught between 15/20 miles East by South
and 18/50 miles North-east of Fraserburgh.

Maturities (Per cent).											
Sample No.	Date		I	II	III	IV	V	VI	VII	Fish Examined	
Fraserburgh 1 & 2	July	5—10	8.2	33.1	42.6	14.0	2.1	—	—	573	
— 3 & 4	—	18—26	3.0	8.8	41.4	35.6	11.2	—	—	560	
— 5 & 6	Aug.	9—29	—	0.4	1.1	8.4	56.7	16.1	17.3	456	
— 7	Sep.	11	—	—	—	4.3	54.3	37.2	4.3	234	

Size Distribution (Per cent).											
Sample No.	22	23	24	25	26	27	28	29	30	31 cm.	
Fraserburgh 1 & 2	1.4	7.8	22.9	29.3	25.8	8.9	3.3	0.6	—	—	
— 3 & 4	—	1.2	5.8	20.6	37.0	24.1	8.4	2.7	0.2	—	
— 5 & 6	—	—	2.4	5.1	14.5	19.1	33.1	18.1	6.1	1.6	
— 7	—	0.4	0.9	4.3	9.8	20.1	31.2	22.2	9.0	2.1	

Age Composition (Per cent).											
Sample No.	Winter Rings										
	2	3	4	5	6	7	8	9	10—13		
Fraserburgh 1 & 2	28.3	38.8	18.3	3.3	6.6	3.7	0.5	0.2	0.3		
— 3 & 4	14.8	41.8	25.8	8.0	6.6	2.4	0.5	—	—		
— 5 & 6	7.8	20.0	12.3	16.0	18.2	9.2	12.0	3.6	0.9		
— 7	7.3	14.1	9.8	12.0	20.1	14.1	19.2	2.1	1.3		

Table 2.
Herring Samples caught between 20/30 miles East-half-South
and 20/40 miles East-North-East of Peterhead.

Maturities (Per cent).											
Sample No.	Date		I	II	III	IV	V	VI	VII	Fish Examined	
Peterhead 1	July	17	1.7	2.6	17.5	39.5	38.8	—	—	235	
— 2	Aug.	1	1.4	5.8	43.9	27.8	21.1	—	—	274	
— 3	—	21	6.8	0.8	19.0	33.5	20.2	2.8	16.9	248	
— 4	Sep.	5	—	—	—	4.3	35.9	5.8	54.0	278	

Size Distribution (Per cent).											
Sample No.	22	23	24	25	26	27	28	29	30 cm.		
Peterhead 1	—	0.9	5.1	9.4	32.4	32.7	15.3	3.8	0.4		
— 2	—	1.1	8.0	34.4	33.9	16.8	4.7	1.1	—		
— 3	0.4	5.6	22.2	27.8	19.4	10.5	8.9	4.0	1.2		
— 4	—	0.7	4.7	11.2	20.1	25.9	22.6	10.8	4.0		

Age Composition (Per cent).											
Sample No.	2	3	4	5	6	7	8	9	Winter Rings		
Peterhead 1	8.1	47.7	22.1	13.2	6.4	1.7	0.9	—			
— 2	20.0	32.2	27.0	12.0	5.9	2.6	0.4	—			
— 3	40.8	26.6	16.1	7.7	4.8	2.4	1.6	—			
— 4	14.0	22.3	15.5	15.8	15.5	8.3	7.9	0.7			

Herring investigations were resumed on a small scale in July, 1945. Sampling was confined to haulings from the fishing grounds off Fraserburgh and Peterhead.

Lack of staff and laboratory accommodation made it impossible to do more than routine observations on size, maturity and age.

The herring fishing grounds were very prolific and landings continuously exceeded the power of the commercial shore staffs to deal with them.

The samples summarised above (Tables 1 and 2) were taken from individual catches ranging from twenty-five to one hundred and forty crans.

H. Wood.

Table 3.

Herring Samples caught NW. of the Dogger Bank.

Maturities and Size Distribution (Per cent).

Length, cm.	21	22	23	24	25	26	27	28	29	Total	Mean Length
Mat. II-III-IV	5	15	9	2	1	—	—	—	—	32 0/0	22.9 cm.
Mat. V-VII	—	6	6	6	16	16	13	4	1	68 0/0	25.8 cm.
Total	5	21	15	8	17	16	13	4	1	100 0/0	24.9 cm.

Age Composition (Per cent) and Racial Characters.

(in brackets: Number of Herring investigated).

Age, Years: Year-Class:	3 1942	4 1941	5 1940	6 1939	7 1938	8 1937	Total	V. S.	V. P.	K ₂
Mat. II-III-IV	28	4	—	—	—	—	32	56.46 (50)	23.60 (50)	14.78 (51)
Mat. V-VI	8	16	22	13	8	2	69	56.39 (72)	24.06 (72)	14.83 (70)
Total	36	20	22	13	8	2	101	56.42 (122)	23.82 (122)	14.81 (121)

Length of the Age-Groups in cm.

(in brackets: Number of Herring investigated).

Age: years	3	4	5	6	7	8
Mat. II-III-IV	22.8 (76)	23.5 (11)	—	—	—	—
Mat. V-VI	22.8 (23)	25.3 (44)	26.0 (61)	27.1 (35)	27.0 (21)	26.7 (5)
Total	22.8 (99)	24.9 (55)	26.0 (61)	27.1 (35)	27.0 (21)	26.7 (5)

Size- and Age-Composition.

A herring fishery from Danish cutters using the Danish herring trawl was started in the summer and autumn of 1945. A sample of the catch obtained N.W. of the Dogger Bank at about 55° 30' N., 30' E. on 21st September was investigated at the Danish Biological Station. The results are given in Table 3.

32 0/0 of the herring were immature young and

small herrings; the rest were mature and chiefly larger and older.

Very few herrings having the mean length of the whole sample were found. The racial analysis shows that both of these maturity groups are autumn spawning herrings of the western North Sea, yet the difference in the praehaemal vertebrae (V. P.) may indicate that the immature herrings (or part of them) belong to a different group within the race than the mature fish.

Age J. C. Jensen

Southern North Sea.

INTRODUCTION.

Contributions to this report on the Southern North Sea area have been made by

Dr. Vedel Tåning, Copenhagen,
Dr. Aage Jensen, Copenhagen,
Mag. Jens Smed, Copenhagen,
Mag. E. Bertelsen, Copenhagen,
Dr. Baerends, the Hague,
M. Gilis, Belgium.
Dr. W. C. Hodgson, Lowestoft,
Mr. R. S. Wimpenny, Lowestoft.

Hydrography. No hydrographic data is available for the period covered by this report, but a paper on surface temperatures in the area, taken from the hydrographical card-index of the International Council has been produced by Mag. Jens Smed. These surface temperatures are given as anomalies and extend from the early years of the century up to 1939. The observations from different parts of the southern North Sea show a measure of agreement and the data puts temperature variations in an area in which fishery biologists working in this area are long required to assist them in their study of thermal fluctuations.

Demersal Catch. This part of the *Annales Biologiques* is the first in which data is produced to show the effect of the war on the fishery so as to compare the yields with those obtained before the war. In the southern North Sea, although fishing was very severely curtailed, trawling from Dutch trawlers off the coast of Holland and seine-net fishing by Danish motor vessels in the east and central North Sea was carried on throughout the war. The rate of fishing for these fleets indicates an increase in the stock density in the neighbourhood of three times the pre-war level.

Haddock. This fish shared in the general increase of species off the Dutch coast during the war. Similarly off the English east and Channel coasts it became very much more abundant than before the war.

Haddock. The Dutch observations show that the haddock has not resulted in any increase in the population of this fish in the southern North Sea. Inquiries from material taken by the Danish seiners point to the occurrence of a strong 0-group in 1944.

Plaice. While all contributors dealing with plaice have noted the very great increase in the density of the stock as indicated by the higher yield per unit time, the Dutch and English observations show that this species has increased relatively more than some of the others. A part of the increase of the Danish fishery in the eastern and central North Sea has been attributed to the strong year-classes 1937, 1939, 1940 and 1941. The exceptionally high catch of 1943 was thought to be largely based on the strength of the 1939 year-class. In this connection it is of interest to note that 1939 was the dominant year-class noticed in the English Channel work.

That the English and Danish results should show an increased proportion of older fish is in accordance with expectancy. On the other hand it is remarkable to record that in some of the areas investigated in both cases there was a rise in size for age in spite of the greater population density. This is the reverse of what would have been thought likely and, taken in conjunction with the fact that the increase in abundance of the plaice has been relatively greater than that of some other species, suggests that a natural fluctuation of conditions may have favoured this fish.

Herring. Such results as it was possible to obtain on the East Anglian herring shoals in the autumn of 1945 suggest an increase in the stock density. There was, however, no demonstrable increase in the weight and length of the different age-groups compared with those of the pre-war period.

Information from the spent-herring fishery of the Belgian coast is available from the seasons 1941—42, 1942—43, 1943—44, and 1944—45. The greatest number of landings and the largest total catch occurred in 1943—44, but throughout the years there was a steady rise in the catch per landing which is not likely to have been fully accounted for by the fact that there was a progressive increase in the average horse-power of the trawlers. In spite of the increased stock it was found that the weight per fish had not fallen to such an extent as to suggest biological starvation due to greater competition for food.

R. S. Wimpenny.

HYDROGRAPHY.

The Variation from Year to Year of the Surface Temperature in the Southern North Sea.

FOR the southern North Sea a considerable number of surface temperature observations, covering a long series of years, is recorded in the hydrographical card-index of the International Council. Temperature observations not combined with salinity determinations are, however, not included in the card-index, nor are all temperature observations from light-vessels. The temperature material recorded in the card-index, although not complete, is still so extensive that it can be expected, when worked up, to supply information of some value to marine biology. Below are given the monthly means of the anomaly of the surface temperature, respectively the monthly means of the temperature itself, year by year up to 1939 for the areas and stations shown in Fig. 1, calculated on the basis of the card-index material and observations from light-vessels. For the years 1940—45 only few observations are as yet available; should sufficient observations be obtained for these years in the future it is intended to publish the relevant data of temperature anomalies, or temperatures respectively, in the *Annales Biologiques* together with the data for 1946 and possibly for later years.

As the temperature of an area varies locally, and as the distribution of the observations over an area ordinarily is not the same from one year to another, monthly temperature means for an area cannot be expected to give comparable values. Therefore the following method was used: Each area in question was divided into squares of $1^{\circ} \times 1^{\circ}$ or $\frac{1}{2}^{\circ} \times \frac{1}{2}^{\circ}$. The grand decade means for their corners for the period 1. July 1905—30. June 1914 are published in the "*Variations de la Température de l'Eau de Surface de la Mer du Nord pendant les Années 1905—1914*" (Bulletin Hydrographique, 1922). From these values the grand decade means of the squares have been obtained by calculating means for each decade and each square from the 4 means applying to the corners of a square. For each of the squares and for each decade of the years 1902—1939 the anomaly of the temperature was then computed. These anomalies were used for computation of mean values for the areas A, B and C and for each month in the years 1902—1939.

The results of the calculations are given in les 1, 2 and 3¹⁾ where the anomalies of the months are recorded together with the number of observations on which they are based; the anomalies are further reproduced in the form of di-

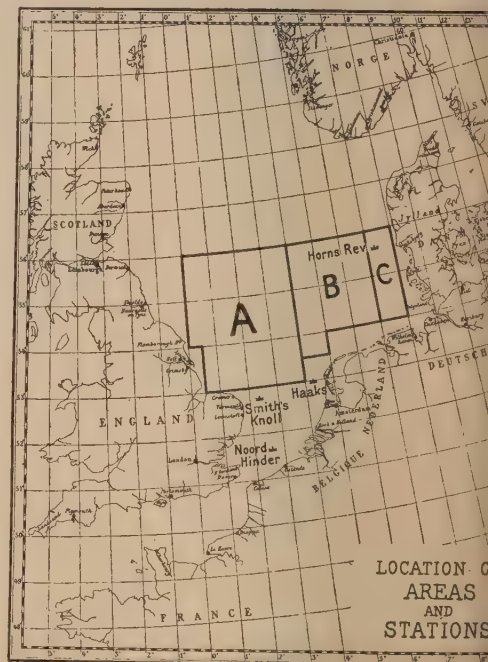


Fig. 1.

in Figs. 2, 3 and 4 so as to permit a general view of their variations. A comparison of the temperature variations in the areas A, B and C shows a considerable conformity.

A great number of surface temperature observations from "Horns Rev" light-vessel (55°

¹⁾ According to the Editor's decision the table will not be printed, but will be kept in the archives of the Council's office from where Leica-film copies may be obtained at request.

(E.) is available for the period 1880—1939. Means for the several months during the whole period are recorded in Tab. 4 according to the Danish *Nautical-Meteorological Annuals* for the relevant years. A graphic representation of the material is given by the solid lines in Fig. 5. In each part-figure the mean surface temperature for the month in question is represented by a horizontal line through the figure. These lines have been drawn on the basis of the temperature means for the years 1881—1917 and 1921—1930 as recorded in the *Mean Values of Observations from Danish Light-Vessels* (Danish Naut.-Met. Annual 1933). From the diagrams in Fig. 5 — as well as from the diagrams in Figs. 2—4 — it is seen that the mean temperatures of adjacent months are to some degree in accordance with each other. In an as yet unpublished paper J. P. Jacobsen has also proved that the coefficient of correlation between the surface temperatures at Horns Rev light-vessel for two successive months is 0.52. For monthly means of temperature with a time distance of 2 months the coefficient was found to be 0.25 and for monthly means with a time distance of 3 months to be 0.22.

Fig. 5 gives also a graphical representation of the variation of the air temperature at Horns Rev light-vessel (the dashed lines). The relevant means have been taken from the Danish *Nautical-Meteorological Annuals* (1880—1939). It is seen from the figure that there exists a quite close connection between the temperature of the air and the surface temperature of the water. A closer investigation of this problem would, however, exceed the scope of this paper.

For the southernmost part of the North Sea an investigation of the variation of the temperature has been limited to the material from light-vessels, i.e. the Dutch light-vessels "Haaks" and "Noord Hinder" and the English light-vessel "Smith's Knoll". This is done on account of the great horizontal temperature gradients in this area. The positions of the light-vessels are given in Fig. 1. From "Haaks" (52°58'N., 4°19'E.) and "Noord Hinder" (51°36'N., 2°36'E.) decade means of the

surface temperature are available, for the years 1906—1911 in *Jaarboek van het Rijksinst. voor het Onderzoek der Zee* (1908, 1909, 1910, 1911), for the years 1912—1914 in *Rapporten en Verhand. van het Rijksinst. voor Visscherijonderzoek* (1913—19) and for the years 1921—1939 in the *Bulletins Hydrographiques*. On the basis of this material the monthly means given in Tables 5 and 6¹⁾ have been calculated. Where one or two decade means were lacking for a month, the values for the lacking decades were calculated by interpolation between the adjacent values, and the monthly means were then calculated in the usual manner; in the tables, such mean values are given in brackets.

A graphical representation of Tables 5 and 6 is given in Figs. 6 and 7 respectively. The horizontal line in each part-figure represents the general mean for the relevant month. These general means are given at the bottom of Tables 5 and 6.

For "Smith's Knoll" monthly means have been calculated for the years 1911—1939 on the basis of the observations published in the *Bulletins Hydrographiques*. These mean values are recorded in Tab. 7 and reproduced graphically in Fig. 8. The horizontal line in each part-figure represents the general means. It should be noticed that the light-vessel "Smith's Knoll" during the period under discussion has been placed in slightly different positions, i.e. January 1911—June 1912: 52°52'N., 2°14'E.; July 1912—September 1914: 52°43.5'N., 2°15'E.; April 1920—April 1939: 52°43'N., 2°17'E. These small differences in the position are, however, not likely to be of any importance for the present discussion.

A comparison of Figs. 6 to 8 shows a high degree of conformity between the variations of the surface temperature at the three light-vessels. A comparison further with Figs. 2 to 5 shows some conformity with the variations in the areas A, B and C. The variations in the surface temperature are evidently to some degree in accordance with one another over large parts of the southern North Sea.

Jens Smed.

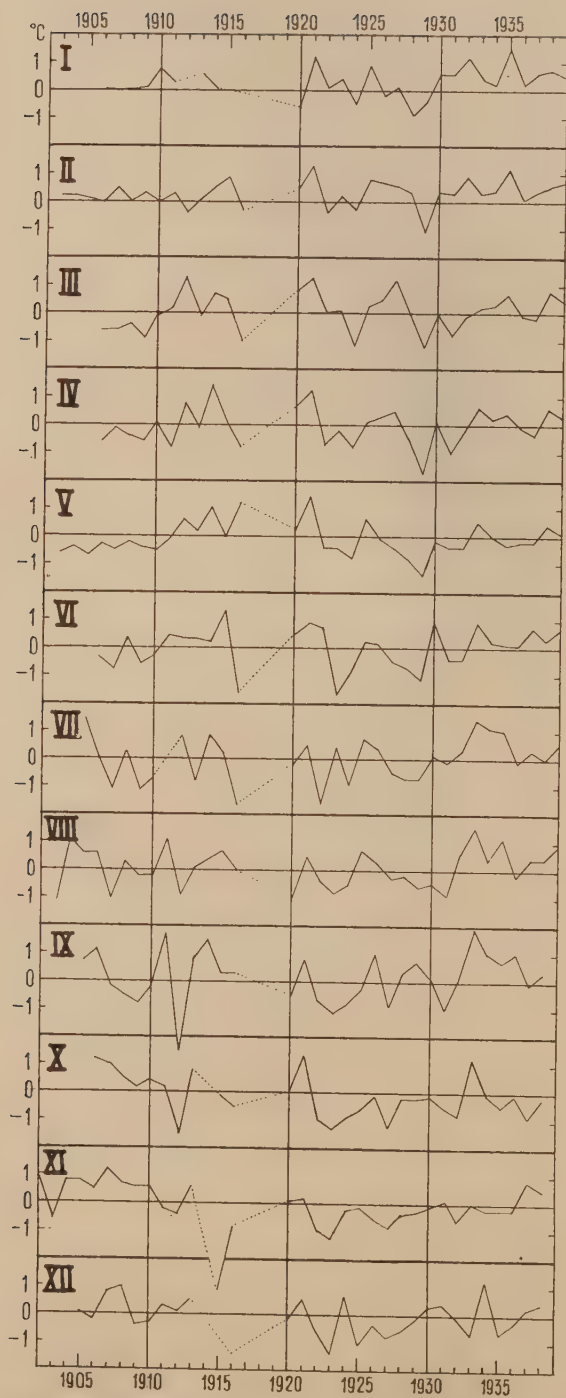


Fig. 2. Monthly anomalies of the surface temperature in the area A (see Fig. 1) during the years 1902—1939.

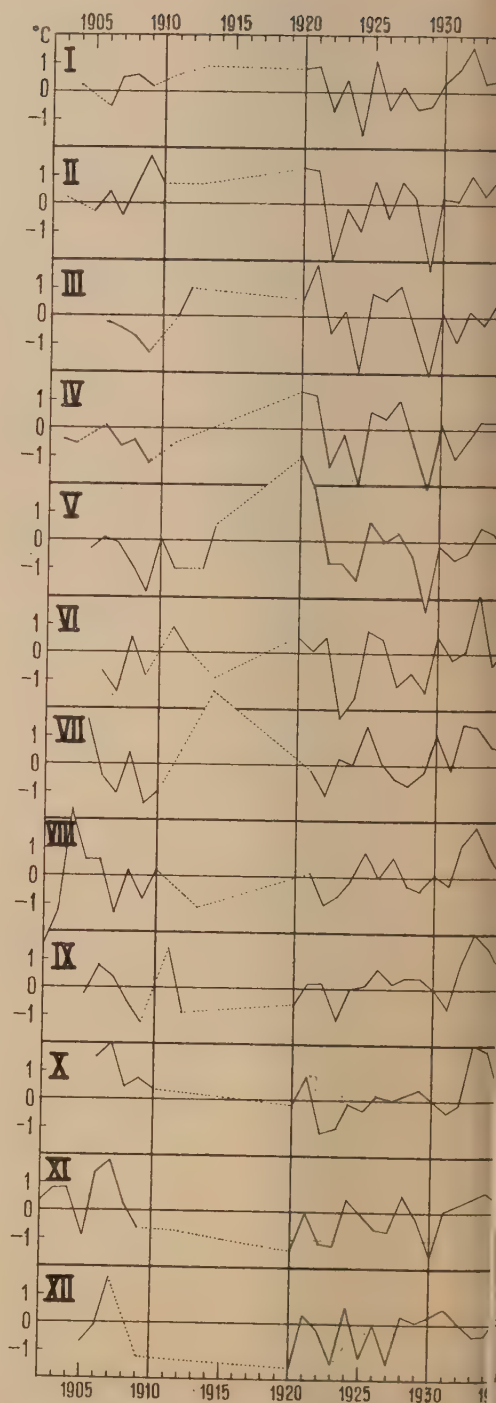


Fig. 3. Monthly anomalies of the surface temperature in the area B (see Fig. 1) during the years 1902—1939.

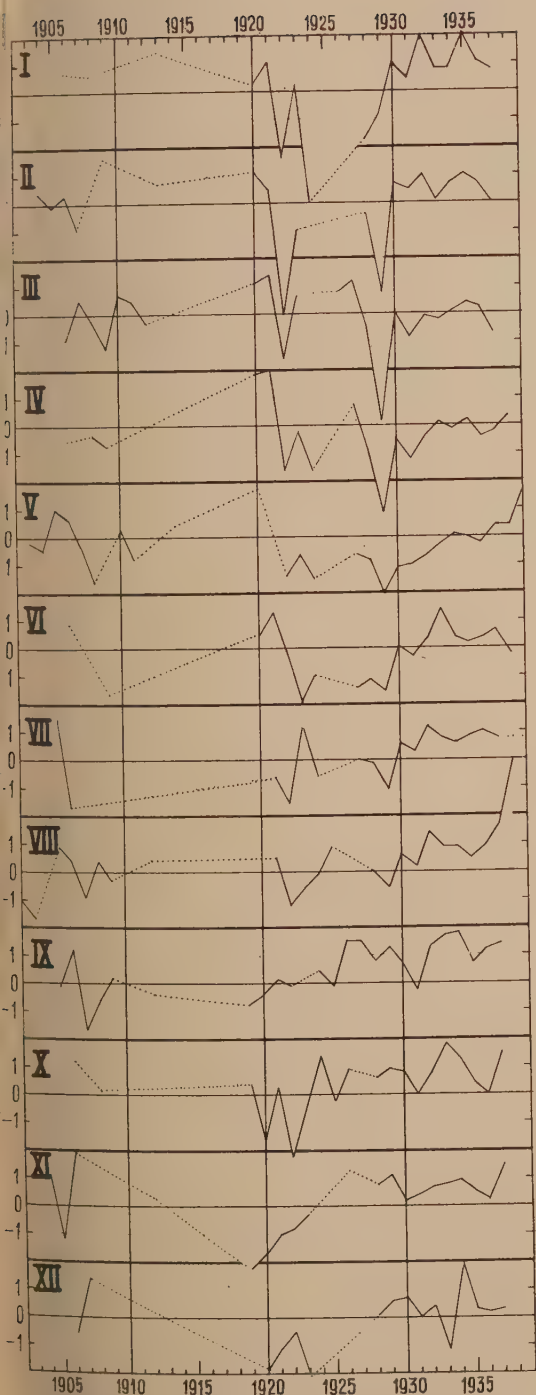


Fig. 4. Monthly anomalies of the surface temperature in the area C (see Fig. 1) during the years 1902–1939.

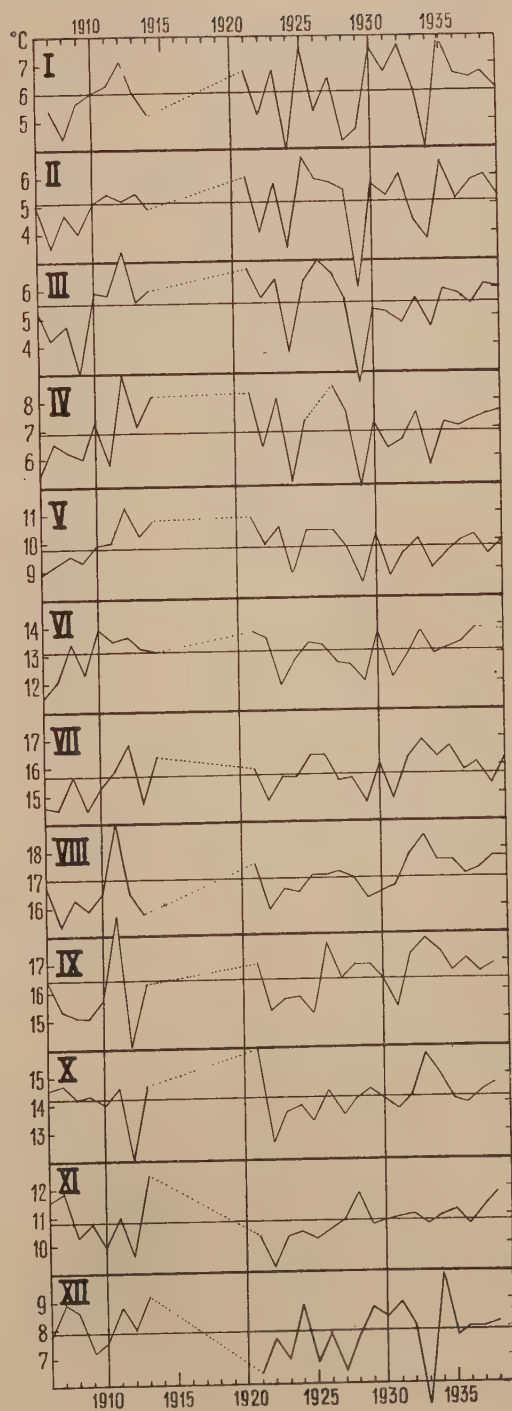


Fig. 6. Monthly means of the surface temperature at Haaks Light-Vessel (see Fig. 1) during the years 1906–1939.

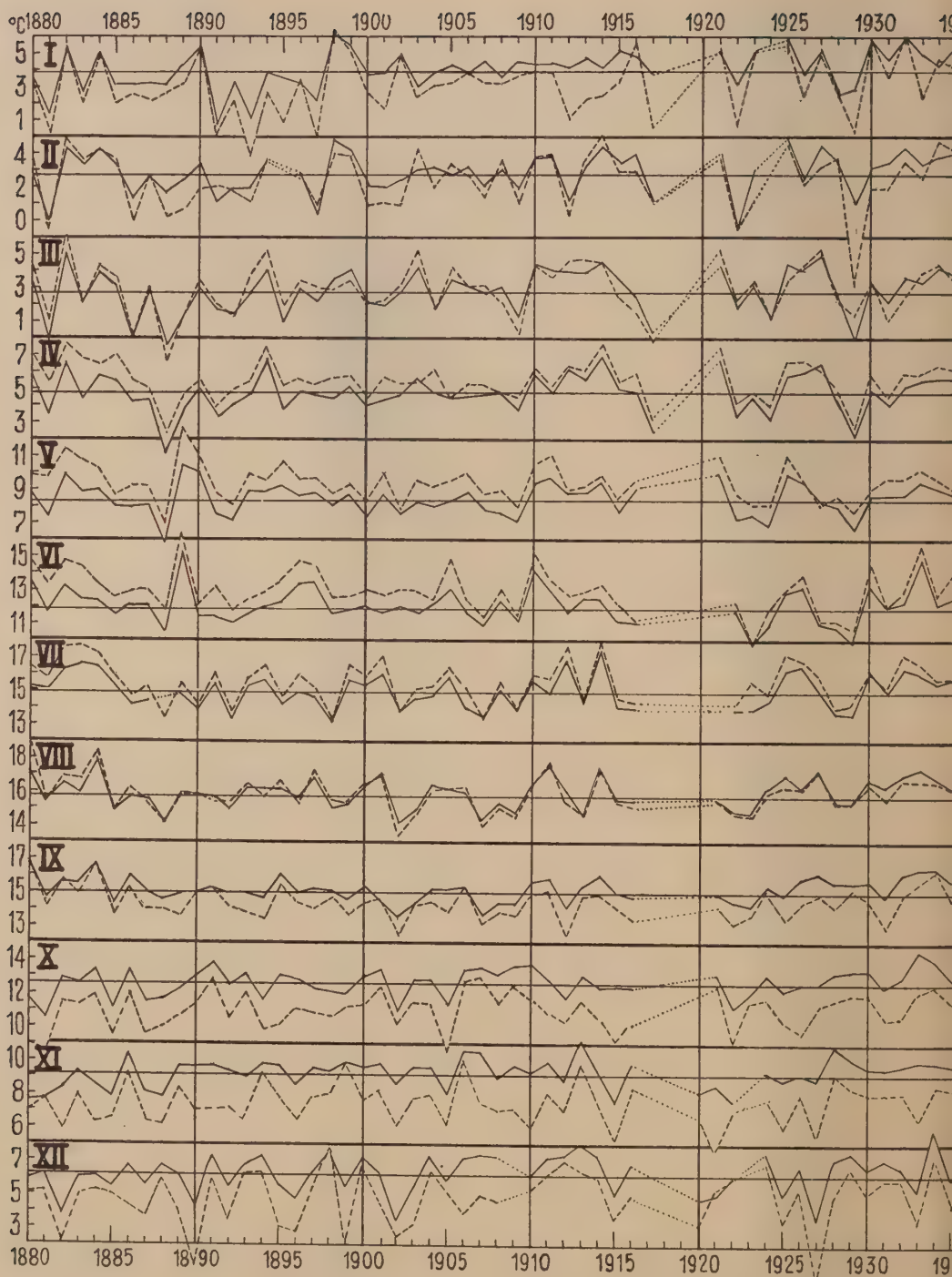


Fig. 5. Monthly means of the surface temperature (solid lines) and of the air temperature (dashed lines) at Horns Rev Light-Vessel (see Fig. 1) during the years 1880—1939.

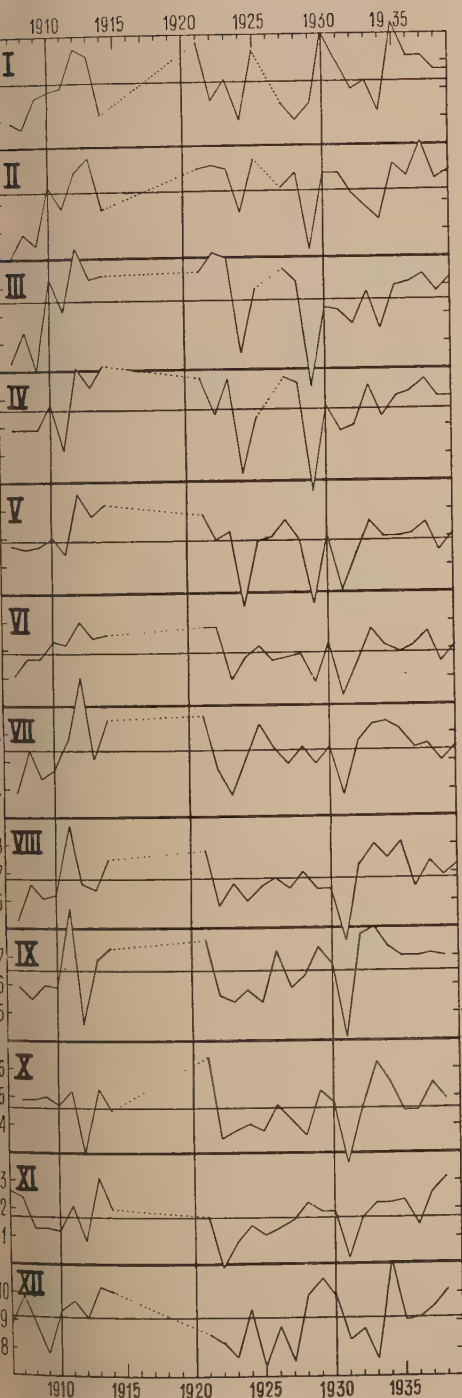


Fig. 7. Monthly means of the surface temperature at Noord Light-Vessel (see Fig. 1) during the years 1906—39.

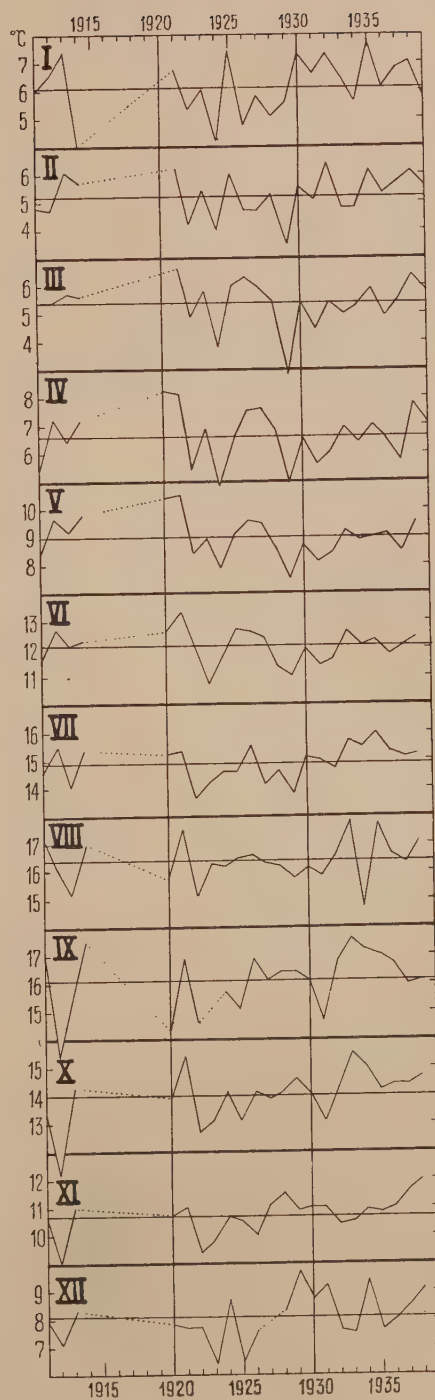


Fig. 8. Monthly means of the surface temperature at Smith's Knoll Light-Vessel (see Fig. 1) during the years 1911—1939.

Denmark.

THE FISH.

Cod and Haddock.

Very few samples of cod and haddock from the North Sea were obtained during the war, when catches of the Danish fishing vessels consisted mainly of plaice. Analyses of the few samples ob-

tained are given below showing distribution length and ages.

According to informations obtained the haddock was abundant in 1944. A sample year-class from 7/11 1944 (locality unknown) an average length of 19.5 cm. (variates 15—22)

E. Berte

Cod from the SE. North Sea.

	cm.:	30— 34	35— 39	40— 44	45— 49	50— 54	55— 59	60— 64	65— 69
1940 20—26/10		12	85	70	94	118	72	30	28
10 Sm. N.W. of Horns Rev									
Danish Seine	0/0	2.3	16.2	13.4	12.9	22.5	13.7	5.7	5.3
1943 22—27/3		—	—	—	—	8	38	23	19
Red Cliff &									
75 Sm. S.W. of Graadyb Barre	0/0	—	—	—	—	4.8	22.7	13.7	11.3
Danish Seine									
1943 24—30/3		—	—	—	—	2	2	—	4
Off Hvide Sande & Hirshals									
Lines	0/0	—	—	—	—	0.6	0.6	—	1.3
1943 5/11		—	—	—	—	—	—	—	—
Off Thyborøn									
Lines	0/0	—	—	—	—	—	—	—	—
1943 5/11		—	—	—	—	17	76	130	63
Red Cliff									
Danish Seine	0/0	—	—	—	—	4.9	22.0	37.6	18.2
1944 16/3		—	—	1	—	2	1	3	7
Clay Deep									
Danish Seine	0/0	—	—	0.3	—	0.5	0.3	0.8	1.8

90— 94	95— 99	100— 104	105— 109	110— 114	115— 119	120— 124	Total	cm.
—	—	—	—	—	—	—	524	1940 20—26/10 10 Sm. N.W. of Horns Rev
—	—	—	—	—	—	—	0/0	Danish Seine
15	8	1	2	2	1	—	168	1943 22—27/3 Red Cliff &
8.9	4.8	0.6	1.2	1.2	0.6	—	0/0	75 Sm. S.W. of Graadyb Barre Danish Seine
59	36	16	10	4	1	1	316	1943 24—30/3 Off Hvide Sande & Hirshals
18.7	11.4	5.1	3.2	1.3	0.3	0.3	0/0	Lines
42	34	16	4	2	1	—	174	1943 5/11 Off Thyborøn
24.1	19.5	9.2	2.3	1.2	0.6	—	0/0	Lines
—	—	—	—	—	—	—	346	1943 5/11 Red Cliff
—	—	—	—	—	—	—	0/0	Danish Seine
80	41	20	8	—	1	—	392	1944 16/3 Clay Deep
20.4	10.5	5.1	2.0	—	0.3	—	0/0	Danish Seine

(Cod, continued).

II. Age-Distribution and Average-Lengths.

	Age-Group		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
1940 20—26/10	No.		168±	289±	58	10	—	—	—	—	—	—	—	—	—
10 Sm. N.W. of Horns Rev	%		32±	55±	11.0	1.9	—	—	—	—	—	—	—	—	—
Danish Seine	Av. L. cm.		39.2	52.2	65.4	76.4	—	—	—	—	—	—	—	—	—
1943 22—27/3	No.		—	—	40	55	28	23	11	5	2	—	3	—	—
Red Cliff &	%		—	—	24.0	33.0	16.8	13.8	6.6	3.0	1.2	—	1.8	—	—
75 Sm. S.W. of Graadby Barre	Av. L. cm.		—	—	—	—	—	—	—	—	—	—	—	—	—
Danish Seine	No.		—	—	56.7	65.1	82.1	86.3	96.4	96.5	102.5	—	110.5	—	—
1943 24—30/3	No.		—	—	3	48	82	93	48	17	9	6	6	2	2
Off Hvide Sande & Hirsals	%		—	—	0.9	15.2	25.9	29.4	15.2	5.4	2.8	1.9	1.9	0.6	0.6
Lines	Av. L. cm.		—	—	54.2	73.9	82.7	89.2	94.5	96.7	103.3	106.2	107.5	107.5	114.5
1943 5/11	No.		—	—	—	30	38	37	29	14	20	5	1	—	—
Off Thyborøn	%		—	—	—	17.2	21.8	21.3	16.7	8.0	11.5	2.9	0.6	—	—
Lines	Av. L. cm.		—	—	—	81.0	87.0	91.7	94.2	100.4	100.4	106.1	104.5	—	—
1943 5/11	No.		—	4	224	118	—	—	—	—	—	—	—	—	—
Red Cliff	%		—	1.2	64.8	34.0	—	—	—	—	—	—	—	—	—
Danish Seine	Av. L. cm.		—	55.0	61.0	69.2	—	—	—	—	—	—	—	—	—
1944 16/3	No.		—	1	—	28	151	85	64	43	13	4	2	1	—
Clay Deep	%		—	0.3	—	7.1	38.6	21.7	16.4	11.0	3.3	1.0	0.5	0.3	—
Danish Seine	Av. L. cm.		—	43.5	—	70.9	82.3	89.1	92.9	96.5	100.0	106.0	109.5	115.5	—

Haddock from the Southern North Sea.

		Length in cm.		Age-Groups and Year-Classes											Total
		30—34	35—39	40—44	45—49	50—54	55—59	60—64	II	III	IV	V	VI	VII	VIII indet.
1944 19/7	No.	2	56	46	45	21	11	1	—	—	—	—	—	—	—
125—135 Sm. W. 1/2 S.	%	1.1	30.8	25.7	24.7	11.5	6.0	1.1	35.1	18.2	14.8	6.0	8.8	—	17.0
of Graadby	Av. L. cm.	—	—	—	—	—	—	—	38.6	43.3	46.6	48.9	52.6	—	—
(abt. 54°55'N. 4°45'E.)	No.	—	2	25	28	32	27	4	—	—	—	—	—	—	—
Danish Seine	%	—	1.7	21.2	23.7	27.1	22.9	3.4	—	20.4	17.8	15.3	13.6	28.8	4.2
1945 20—29/5	No.	—	2	25	28	32	27	4	—	—	—	—	—	—	—
120 Sm. E. to N. of	%	—	1.7	21.2	23.7	27.1	22.9	3.4	—	20.4	17.8	15.3	13.6	28.8	4.2
Humber Lightship	Av. L. cm.	—	—	—	—	—	—	—	—	—	—	—	—	—	—
(abt. 54°15'N. 3°30'E.)	No.	—	2	25	28	32	27	4	—	—	—	—	—	—	—
	%	—	1.7	21.2	23.7	27.1	22.9	3.4	—	20.4	17.8	15.3	13.6	28.8	4.2

ice.

Observations on Young Plaice in the Danish Waddensea during the War.

RESEARCH work on the stock of young plaice has been continued in the Danish Waddensea during the war-period. Johansen's young-fish trawl was operated as previously, especially in the northern part of the area (cf. part in "A.B." Vol. I, p. 136 and the text pp. 135—136). Owing to German military operations in the area it was, however, difficult in some years to get the work accomplished, especially in 1944. Sufficient material was not obtained. In all years (except 1939 and 1944) 27—54 hauls were made every year with the young-fish trawl in different localities 3—4 times, particularly during the months June to October.

Table 1.
0-Group Plaice per Hour in the Northern and Southern Area (cf. chart Fig. 1, "A.B.", I, p. 136).

Northern Area.			
Year	No. of Hauls	No. of Spec.	Av. per Hour
1936	36	3,032	337
1937	26	2,706	416
1938	21	373	71
1939	14	1,233	352
1940	41	2,342	228
1941	29	1,612	222
1942	35	353	40
1943	27	1,189	176
1944	14	259	74
1945	39	2,394	246
Southern Area.			
1936	24	1,129	188
1941	15	964	257
1942	9	93	41
1945	15	450	120
Total.			
1936	60	4,161	277
1937	26	2,706	416
1938	21	373	71
1939	14	1,233	352
1940	41	2,342	228
1941	44	2,576	234
1942	44	446	41
1943	27	1,189	176
1944	14	259	74
1945	54	2,844	211

Table 2.
Monthly Average Number per hour of 0-Group Plaice in the Waddensea 1939—1945.

	Month of Operations				
	June	August	Sept.	Oct.	Nov.
1939	168	—	—	455	—
1940	149	—	229	326	—
1941	20	291	—	386	—
1942	0	181	31	3	—
1943	103	—	337	58	—
1944	7	—	134	—	20
1945	100	292	—	208	—

Table 1 shows that during the war the year-class 1939 was the best, but at least three other year-classes were fairly good.

Table 2 gives a survey of the number of 0-group plaice per hour in the various months, showing as previously that the highest numbers of the 0-group are met with in the Waddensea during August—October.

Table 3, which shows the yearly average number per hour of the different age-groups for a pre-war-period (1935—39), the war-period (1940—44) and a post-war year (1945), emphasizes the great increase during the war in average number per hour of the I-group and older year-classes.

Table 3.
Average yearly Number per Hour of the different Age-Groups in the Waddensea.

	Age-Groups					
	0	I	II	III	IV	V
1935	151	61	15	2	2	1
1936	277	67	8	2	<1	—
1937	416	276	50	3	—	—
1938	71	60	20	4	—	—
1939	352	120	124	11	1	—
Mean 1935—39:	254	117	43	4	1	<1
1940	228	183	7	4	<1	—
1941	234	114	21	1	<1	—
1942	41	374	45	3	—	—
1943	176	249	288	59	<1	—
1944	74	266	114	46	2	—
Mean 1940—44:	151	237	95	23	1	0
1945	211	342	154	33	5	<1

Table 4.
Average Size in June of Plaice 1+, 2+ and 3+ years old.

Year	Age-Groups		
	I	II	III
1934	8.73	13.52	15.95
1935	9.30	13.44	(16.66) ²⁾
1936	8.81	14.75	(17.38)
1937	8.75	12.14	—
1938	—	—	—
1939	11.12 ¹⁾	13.81 ¹⁾	—
1940	10.75	16.61	(19.75)
1941	10.17	16.36	(20.63)
1942	7.85	15.08	(21.75)
1943	7.54	11.95	15.34
1944	8.48	11.41	(15.00)
1945	8.64	11.93	(15.60)

¹⁾ July 7th.

²⁾ Averages of Numbers below 25 specimens in brackets.

Finally Table 4 gives the average size of one-, two- and three-year-old plaice in the of June, and shows that the great increase in density during the war has caused a considerable decrease in average size.

A. Vedel Tø

Changes in the Stock during the War, and the Danish Fishery in the North Sea.

During the years 1940—45 the Danish market investigations of plaice carried out by the "Kommissionen for Danmarks Fiskeri- og Havundersøgelser", Dr. Tåning's Department, have been continued. The official "allowed" fishing areas were restricted to a narrow zone along the coast of Jutland, mainly to the east of 7° E. Long., but a rather considerable fishery was carried out to the west of these limits, and samples were collected secretly from this western area.

Size Composition of Catches from various Parts of the North Sea.

The position of commercial catches of plaice investigated has been shown in Fig. 1. This does not present a complete picture of the fishing intensity at the various grounds since catches from the more distant grounds were, by preference, selected for investigation.

From Table 1 it is evident that a pronounced increase in the length of the plaice caught has taken place in all the fishing grounds covered by this investigation. In some cases, as with the nursery grounds for young plaice off Esbjerg and from the White Bank, a minor increase in the size of mesh used contributes to a small degree to the displacement in the size composition in catches; sometimes the small plaice were not required by the fishermen when the larger sizes were abundant.

A survey of the change has been given in Table 2.

Age Composition of the Catches

It seems that very small changes in the composition of the stock have occurred in the very ground and the White Bank area as compared with pre-war years (cp. Table 3).

In a single instance the older plaice seem to have been more common than normally (cp. 3, White Bank, June), but perhaps this is due to a fault in the statement of the position, since the same sample the length of the age-group was found to be unusually great for the position (cp. Table 4 and text below).

At the fishing grounds in the central North Sea the older plaice were found to be more abundant in the catches than before the war in each of the cases where material for a comparison is at hand.

Length of the Age-Groups.

At first sight it might be feared that the increased density of the stock would very much decrease the growth-rate, thus presenting a growing and less valuable fish to the market. This has not occurred. The average length of each of the age-groups has not decreased during the war in the heavily fished part of the North Sea (White Bank), in one of our comparisons on the contrary it is found to have increased very much.

This last result is rather astonishing, but it is not to be excluded that it may be due to a fault in the statement of the position. However the

Table 1.
Percentage Size Composition.

Nursery grounds off Esbjerg; size composition of plaice over 27 cm.

Ground Season Year Month Depth, m. No. of samples Cm.	Esperance Bay Oct.—Dec.			Between Blaavand and Sild March—May					NW. of Slugen May—July			
	1932 XII 6—13 7	1940 X-XI 6—7 2	1942 X-XI c. 10 2	1935 III 15—17 5	1936 V 12—14 2	1939 IV 12—15 4	1941 V 15—17 2	1943 III 5—15 11	1937 VI 27 1	1940 V 17—21 9	1941 VI 18 1	1942 VI-VII 25 3
27—28	79	87	82	73	71	70	69	59	64	62	65	47
29—30	20	11	16	23	21	23	25	31	23	28	20	32
31—32	1	—	3	4	7	7	5	8	6	8	13	13
33—34	—	—	—	—	1	1	—	2	5	2	2	5
35—36	—	1	—	—	—	—	—	—	1	—	—	3
	100	99	101	100	100	101	99	100	99	100	100	100

Ground Season Year Month Depth, m. No. of Samples Cm.	White Bank June—July			Aug.—Oct.			Central Clay Deep northern Oct.—Nov.				March	
	1937 VI 36—45 10	1943 VI-VII 41—43 8	1945 VI 40—49 12	1935 X 45 3	1941 VIII 41—43 4	1943 IX 40—45 3	1935 X 47—51 2	1941 XI 49 1	1942 X-XI 45 2	1945 X-XI 44—51 4	1935 III 47 1	1944 III 47 1
23—25	14	5	—	0.3	3	—	—	—	—	—	3	—
26—30	78	69	11	77	60	40	35	36	9	5	74	3
31—35	7	25	60	20	34	54	34	45	42	46	20	64
36—40	0.3	1	26	3	3	5	21	18	42	42	2	21
41—45	—	0.4	2	0.3	0.5	0.6	7	1	6	6	1	9
46—50	—	—	0.2	0.1	—	0.2	2	—	1	1	0.5	3
51—55	—	—	—	—	—	—	—	—	0.1	—	—	—
	99	100	99	101	100	100	99	100	100	100	100	100

Ground Season Year Month Depth, m. No. of samples Cm.	Tailend May—June					Dogger Sept.—Oct.			N. edge of Dogger July			
	1935 V 35 1	1938 VI 37 1	1941 V 38 1	1941 VI 35 1	1945 VI 32 1	1937 X 30—45 2	1938 IX 34 1	1943 IX 37 1	1935 VII 36—45 2	1945 VII c. 45 5	1938 IX 53 2	1943 IX 48—80 2
26—30	15	24	2	16	2	12	12	3	12	2	11	0.5
31—35	37	33	32	65	21	48	41	28	41	11	46	8
36—40	32	37	54	18	35	21	38	45	28	30	26	29
41—45	12	5	11	0.4	27	7	8	15	21	32	12	34
46—50	3	0.7	0.7	—	8	7	0.3	9	6	18	3	24
51—55	1	0.5	0.2	—	5	3	1	—	2	5	1	3
56—60	0.4	0.1	0.1	—	2	2	1	1	0.6	2	0.5	1
61—65	—	—	—	—	—	—	0.1	—	0.1	—	0.2	—
	100	100	100	99	100	100	101	101	101	100	100	100

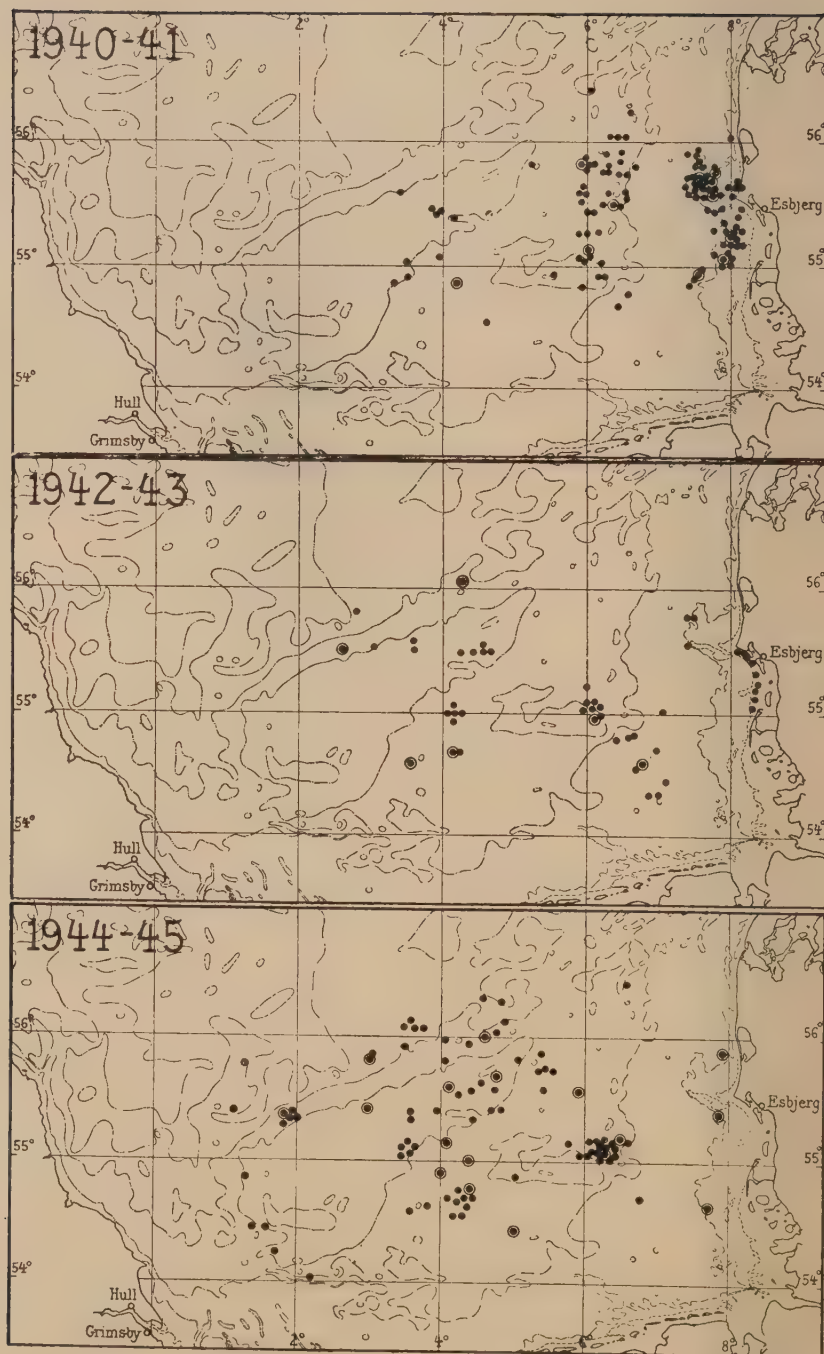


Fig. 1. Localities of Commercial Catches of Plaice Investigated.
• Measurements. ○ Measurements and Samples of Otoliths.

Table 2.
The Percentage Number and Preliminary Figures for Weight of Plaice.

Nursery Grounds off Esbjerg (Sept.—Oct.)		White Bank (June—July)		Clay Deep northern Part (March—Apr.)		S. of Clay Deep, near Puzzle Hole (Oct.—Nov.)		Dogger Bank, Tail-End, (May—June)		N.W. Edge of Dogger Bank (June—July)	
0/0 of No.	0/0 of Kg.	0/0 of No.	0/0 of Kg.	0/0 of No.	0/0 of Kg.	0/0 of No.	0/0 of Kg.	0/0 of No.	0/0 of Kg.	0/0 of No.	0/0 of Kg.
ce >31 cms.											
—38	4	7	9	14	33	50	46	55	80	90	99
—	—	—	—	—	—	—	—	—	91	95	—
—	—	—	—	—	—	—	91	96	—	—	—
—	—	26	38	—	—	—	—	—	—	—	—
—	—	—	—	97	98	—	—	—	—	—	—
—	57	68	28	41	—	—	95	98	98	99	99
ce >36 cms.											
—38	0	0	0.2	0.6	8	19	18	32	46	64	58
—	—	—	—	—	—	—	—	—	42	52	—
—	—	—	—	—	—	—	49	65	—	—	—
—	—	1	3	—	—	—	—	—	—	—	—
—	—	—	—	33	47	—	—	—	—	—	—
—	21	35	2	5	—	—	49	62	77	88	87
—	—	—	—	—	—	—	—	—	—	—	94

Table 3.
Percentage Age Composition.

Aug.—Sept.		White Bank		June		Clay Deep Oct.—Nov.		N. of Tailend Sept.—Nov.		N. of Dogger Sept.—Nov.	
1940	1941	1945	1937	1943	1945	1941	1942	1945	1943	1945	1943
IX	VIII	VIII-IX	VI	VI	VI	XI	X	X	XI	IX	IX
49	45	42	37—41	43	44—49	49	45	51	60	48	48
I-group											
—	—	—	—	—	—	1	—	—	—	—	—
I	11	38	20	34	5	19	1	2	3	0.4	—
V	65	48	53	42	65	13	13	29	38	11	3
V	21	13	21	22	28	37	28	43	19	37	24
I	2	0.6	6	3	0.6	41	13	34	27	33	37
I	1	—	—	—	0.3	5	—	25	13	13	27
I	—	—	—	—	2	—	1	5	1	4	6
X+	—	—	—	—	2	—	—	1	—	1	2
—	—	—	—	—	—	—	—	—	—	—	1
100	100	100	101	99	100	99	99	100	101	99	99

Table 4.
Average Length, in cm., of the Age-Groups.

White Bank						N. of Tail End		Near Middle Rough	
			Aug. - Sept.			Sept. - Nov.		Sept. - Nov.	
1937	June	1945	1940	1941	1945	1943	1945	1943	1945
VI	VI	VI	IX	VIII	VIII - IX	XI	IX	IX	X - XI
37-41	43	44-49	47	45	42-49	60	48	48	35-72
—	—	—	26.9	28.4	26.8	—	—	—	—
27.1	27.6	32.9	27.4	28.9	28.1	38.4	34.7	39.5	37.7
28.3	29.2	34.2	26.8	28.1	30.8	40.3	35.5	43.2	39.2
—	—	—	—	—	—	43.0	37.7	45.9	40.6
—	—	—	—	—	—	44.8	38.4	49.4	43.2
—	—	—	—	—	—	—	—	52.2	46.5

Table 5.
Average Landings in Esbjerg from some Cutters taken at Random
(the number of landings in brackets).

Area Depth Month	E. of the Tail-End 40—55 m.		Tail-End 25—35 m.	N. Edge of Dogger 40—60 m.
	June—Sept.	Oct.—Nov.		
1935—38	2,415 kg. (18)	1,691 kg. (9)	2,344 kg. (6)	2,472 kg. (3)
1940	4,874 „ (27)	—	—	—
1943	11,139 „ (8)	—	—	—
1945	3,530 „ (17)	5,361 „ (3)	6,041 „ (14)	6,158 „ (5)

a possibility that it is correct; no doubt the fishing was more unevenly distributed over the fishing ground thus leaving some places for a better growth increment of the fish. Normally the length is determined 1) by the growth, 2) by the fishing preferentially removing the fastest growing fish.

On more distant grounds in the central North Sea, where the density undoubtedly had increased much more, a diminution of the growth-rate seems to have taken place (cp. Table 4, N. of Tail-End, and near Middle Rough). Nevertheless the decrease in the average lengths found is by no means alarming.

The Catch per Fishing Unit.

The increase of the catch per fishing unit is even greater than that of the catch per landings as the duration of each fishing trip was usually shorter during the later years than in 1935—38, and, furthermore, shorter lines have now been used in hauling than normally.

The Yield of the Fishery.

Table 6.
The Annual Yield of the North Sea Plaice Fishery.

	From Denmark landed		From all Countries In Mill. kg.
	in Denmark	in England	
1931—34	13.5	3.5	52.2
1935—38	11.3	2.7	46.7
1939	13.3	ca. 3.0	16.3+?
1940	18.4	?	18.4+?
1941	29.3	?	29.3+?
1942	38.6	?	38.6+?
1943	52.2	?	52.2+?
1944	33.0	?	33.0+?

Some unknown quantities have been landed in England by Danish cutters during the later years

of the war. During the first years of the war the fishery for plaice was carried out from England, the Netherlands and Germany as well. The quantities landed in these countries are not known, yet, but except for some single years we may assume that the total yield of plaice has not been very much lower than in normal years.

The increase of the catch per fishing unit of 300 percent at least cannot be explained by the rather small diminution of the total fishing effort (or the total yield). The good year-classes of 1939, 1940 and 1941 (cp. Tåning, Ann. Bi. p. 137 and II p. 53) have contributed to the increase of Danish catches in 1941—45. Thus the existence of a great number of plaice originating from the good brood-year 1939 has contributed to the extraordinary great Danish catch in 1943 (cp. Table 3). The main factor for the great increase of the commercial value of the stock may be found in the change in the fishing methods. Before the war two thirds of the total yield of plaice was caught with the otter-trawl, while during the war fishing with the Danish seine became predominant. The otter-trawl with its stiff meshes of about 72 mm. stretched to the length at the most and the rather long hauls were destructive to the stock of undersized fish. Danish seine on the other hand is protective and a count of the following facts:

1. The rather large meshes of about 125 mm. allowing the undersized plaice (below 25 mm.) to escape, as well as the rubbish which would damage the fish caught.
2. The twine used in the Danish seine is slender and flexible thus giving the fish the full advantage of the large meshes.
3. The implement is drawn slowly over the bottom and in short hauls. The small number of undersized plaice caught are rejected alive.
4. The implement needs a fine sandy or silty bottom, whereby the rough grounds are reserved to the growth of the fish.

from the change in the fishing methods, and contemporary changes in the stock and in the yield per fishing unit we may see a brilliant confirmation of the fundamental law steadily asserted by the fishery biologists in previous years that the

yield per fishing unit (the profit of the fishery), and the total yield can be increased very much by a moderate intensity of fishing sparing the undersized fish.

Aage J. C. Jensen.

Holland.

A Survey of the Dutch Fishery for Demersal Seafish in the Years 1939—1945.

By

G. P. Baerends.

WITH the purpose of giving a picture of the intensity of the Dutch fishery for bottom fish during the war and the changes that may have occurred in the stock fished by Dutch vessels I am presenting here a short survey of the effort and results of the Dutch fishing fleet in the years of the war and the year of liberation.

When in the beginning of September 1939 war had broken out the greater part of the Dutch fleet of steam trawlers stopped fishing. But stimulated by some improvements in the conditions of labour many trawlers resumed fishing in the second part of October. However, the number of voyages was less than half the number it used to be in the corresponding months of earlier years. A decrease in the number of voyages of motor luggers practising the trawl fishery always occurs in the last quarter of the year, because then a great number of luggers take up the herring drift-net fishery for which they were actually built. In the autumn of 1939, however, the number of voyages dropped to one sixth of the usual number and that is undoubtedly due to the influence of the war. The small motor vessels like cutters and "botters" continued their activity nearer the coast in an almost normal way. The drop of the total quantity of trawl fish landed, from 47,139,777 kg. in 1938 to 36,830,429 kg. in 1939 is mainly due to the diminished activity of the steam trawlers.

In the first four months of 1940 the fishing intensity of the steam trawlers remained on this level until the 10th of May, when the Germans invaded the Netherlands. Then fishing was stopped entirely. In the course of June 1940 some fishery during daytime was allowed from the port of Scheveningen within the 3 miles zone from Kijkduin to Zandvoort. In the beginning only 20 small motor vessels took part in this fishery but in the course

of the year this fleet of small vessels increased about its April level. At the end of 1940 steam luggers joined this fishery; steam trawlers did not get permission to go to sea. In the beginning of 1941 a greater area comprising the IJmuiden ground, the Broad Fourteens and the Egmond ground was opened for fishing at night. Now steam trawlers and luggers got permission to fish in these regions. At the same time a second coastal zone was opened to the fishery at daytime, namely a zone within the 3 miles limit from Wijk aan Zee to Petten. At the end of April 1942 steam trawlers were no longer tolerated at sea. So only motor luggers went on fishing at the Broad Fourteens. At the end of July 1942 all night fishery was stopped by the occupying authorities but vessels could still visit the offshore area during the day. However, as the war went on, this fishery too was more and more hampered by the Germans until in February 1943 the fishery with motor luggers from IJmuiden was stopped entirely. From that time till about April 1945 21 luggers, 4 steam trawlers and 4 cutters went out fishing in the German Bight from the port of Delfzijl. The small motor vessels operating in the coastal zones, though also greatly hampered in their activity by many prohibitive regulations, continued the fishery till about August 1944 when in connection with the allied invasion all fishing off the coast of Holland was forbidden.

From the number of voyages as given in Table 1 one does not get the impression that from 1941 to 1944 the fishing intensity was decreasing. We believe that a decrease must have taken place for in the first place a great number of vessels were confiscated by the Germans and as they usually took the best ones the vessels of the lowest capacity remained in the fleet. Table 2 gives a picture of the decrease in the number of steam trawlers and small motor vessels during the war. The decrease

Trawl Fishery

Seine Fishery

Period	Steam Trawlers			Motor Trawlers and Motor Luggers			Small Motor Vessels			Motor Luggers			Small Motor Vessels		
	No. of Voyages	Quantity landed	No. of Voyages	No. of Voyages	Quantity landed	No. of Voyages	No. of Voyages	Quantity landed	No. of Voyages	No. of Voyages	Quantity landed	No. of Voyages	No. of Voyages	Quantity landed	No. of Voyages
1st Quarter	449	7,413,088	668	3,004,469	1,881	889,500	—	—	—	—	—	—	94	9,162,394	—
2nd Quarter	347	7,049,142	798	2,784,052	4,963	1,438,542	—	—	—	—	—	—	346	512,867	—
3rd Quarter	243	5,710,919	442	1,481,082	4,960	1,214,899	—	—	—	—	—	—	225	488,169	—
4th Quarter	105	4,018,062	51	243,122	2,643	1,135,938	—	—	—	—	—	—	14	77,805	—
Total	1,144	24,191,211	1,959	7,512,725	14,447	4,678,879	—	—	—	—	—	—	679	1,241,235	—
1st Quarter	155	4,187,379	213	1,150,913	574	697,184	—	—	—	—	—	—	105	555,350	—
2nd Quarter	111	2,276,613	289	1,173,745	1,715	846,337	—	—	—	—	—	—	124	509,799	—
3rd Quarter	—	—	—	—	—	565,434	—	—	—	—	—	—	52	33,401	—
4th Quarter	—	—	599	269,726	3,493	1,178,810	—	—	—	—	—	—	162	83,470	—
Total	266	6,463,994	1,101	2,594,384	8,248	3,269,765	—	—	—	—	—	—	443	1,182,020	—
1st Quarter	22	200,857	1,416	1,863,760	3,867	1,445,433	—	—	—	—	—	—	9	17,944	—
2nd Quarter	156	989,813	579	1,211,084	4,138	1,408,648	—	—	—	—	—	—	436	384,709	—
3rd Quarter	178	1,267,034	743	1,633,790	4,827	1,230,012	—	—	—	—	—	—	501	411,037	—
4th Quarter	314	1,180,176	961	1,085,028	4,849	1,736,400	—	—	—	—	—	—	273	194,378	—
Total	670	3,637,880	3,704	5,793,662	17,681	5,820,493	—	—	—	—	—	—	1,219	1,008,068	—
1st Quarter	704	2,132,850	587	1,846,720	2,823	1,200,619	—	—	—	—	—	—	143	117,289	—
2nd Quarter	99	256,930	293	1,172,266	4,752	1,914,690	—	—	—	—	—	—	394	479,971	—
3rd Quarter	363	329,025	632	444,545	3,659	572,439	—	—	—	—	—	—	534	247,448	—
4th Quarter	324	776,499	665	860,409	2,775	790,225	—	—	—	—	—	—	198	148,215	—
Total	1,490	3,495,304	2,177	4,323,940	13,982	4,477,973	—	—	—	—	—	—	1,269	992,923	—
1st Quarter	401	878,555	1,117	1,180,690	2,681	942,769	—	—	—	—	—	—	189	186,065	—
2nd Quarter	335	630,853	2,123	1,671,617	2,799	884,525	—	—	—	—	—	—	192	153,903	—
3rd Quarter	255	406,434	1,750	824,989	3,096	550,053	—	—	—	—	—	—	667	366,064	—
4th Quarter	318	474,543	1,683	882,126	2,815	598,466	—	—	—	—	—	—	355	275,483	—
Total	1,309	2,390,385	6,673	4,559,422	11,391	2,975,813	—	—	—	—	—	—	1,403	981,515	—
1st Quarter	127	182,960	570	241,355	2,640	837,088	—	—	—	—	—	—	321	237,737	—
2nd Quarter	49	487,217	110	609,714	2,454	1,422,583	—	—	—	—	—	—	729	766,625	—
Total	176	670,177	680	851,069	5,094	2,259,671	—	—	—	—	—	—	1,050	1,004,362	—

was still greater than illustrated by this table, as some of the ships that were added to the fleet to replace confiscated ships were of much lower capacity, and had not been in use in previous years. Especially when in the summer of 1942 all reasonable good cutters and "botters" were confiscated, the fishermen tried to compensate this loss by using the most quaint collection of small inland fishing vessels, pleasure yachts etc. The stoppage of the night fishery in July 1942 meant an appreciable diminution of the fishing intensity which is also not expressed in Table 1. Thirdly the shortage of fuel oil led to the use of gas-producers especially on the luggers. The capacity of a motor driven by means of a gas-producer is about 35 0/0 less than when oil fuel is used.

At the resumption of the fishery in 1945 the steam trawlers became active again. Their number increased gradually when trawlers which in 1940 had managed to reach Great Britain came home and when confiscated Dutch vessels were recovered in German ports and could be repaired again. The area which they fished increased according to the progress of mine sweeping. The area including the Brown Bank, the New Sealand Ground, the Cleaver Bank and the western Oyster Grounds is mostly frequented nowadays. Some bigger trawlers also visit the northern North Sea. The trawling luggers usually remain somewhat nearer the ports, the small vessels keep on frequenting the coastal area.

Table 1 gives the quantities of fish landed during the different years of the war. Table 3 gives the quantities landed in 1945 at the principle fishing port of the Netherlands, IJmuiden. Returns of the total quantities landed at all Dutch ports are not yet at our disposal.

The first question interesting us is whether these data can give us any idea of the size of the profit the North Sea stock has had from the war. Therefore the quantities landed per time unit for 1945 have been given in Table 4. We will compare these quantities with the mean values of similar quantities of corresponding months of the years 1933 and 1934. The reason that we did not chose

more recent years is that after 1934 the Dutch statistics do not give separate data for the fisheries for demersal fish and for herring.

The ratio between the quantities landed days absence by steam trawlers in 1945 and 1934 is 2.77. The ratio between the quantities landed per voyage by motor luggers in the different periods is 2.78, that of the small motor vessels is 2.68. These three ratios fit extraordinarily well with each other.

In his article on a Theory of Fishing (Jodou Conseil, 1935) Mr. Graham has constructed a growth curve of the North Sea stock. On this curve the empirical weight of the stock about 1911 is 70. According to our figures the present stock should be 2.73 times as dense, therefore it should have a weight of 191. That is exactly the value Graham finds for the density after the first world war, in 1919. However, it seems likely that during this war that lasted one year longer, the fishes should have had more respite than during the first war. So, unless 191 should mean the minimum limit for the weight of the stock, which is not likely, we might expect to find a higher value after this war. Now the value of 191 is based on a comparison of the catches per days absence of steam trawlers in 1934 and 1945 but we may also assume that the mean fishing capacity of steam trawlers in 1945 was lower than in 1934. Therefore it is likely that the present stock is more than 2.73 times denser than the stock in 1933, and thus has reached a weight somewhat above but below the maximum limit of 220 which is assumed by Graham. That means that the relative weight of the stock as calculated from our data given here fits pretty well with the curve drawn by Graham and can therefore be considered as an argument to prove the correctness of the curve and consequently also of the estimated optimum catch that can be taken from the North Sea.

In Table 5 the percentage to the class "small" of the total quantity landed (weight) and for plaice and sole also the percentage of fish under 25 cm is given. For comparison data of the percentages "small" in the years 1934 and 1938 are added.

Table 2.
Number of Vessels engaged in Trawl- and Seine Fishery.

	1940 Quarter				1941 Quarter				1942 Quarter				1943 Quarter				1944 Quarter
	Apr.	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II
<i>Trawl Fishery</i>																	
Steam Trawlers	42	—	—	6	12	18	23	25	24	12	14	14	11	10	9	9	7
Motor Luggers	78	—	35	49	43	48	48	55	46	36	47	56	65	60	53	45	5
Small Motor Vessels	169	106	157	148	173	191	230	209	260	264	185	188	156	158	152	155	16
<i>Seine Fishery</i>																	
Motor Luggers	1	1	2	2	3	8	8	1	9	8	—	—	—	1	—	—	—
Small Motor Vessels	25	2	9	2	16	21	21	9	33	37	31	23	18	27	27	30	6

Table 3.

Quantities (in Kg.) of Demersal Fish landed in 1945 at the Port of IJmuiden

Species	Market Categories	June	3rd Quarter	4th Quarter	Total Quantity
Brill		3,288	20,360	13,318	36,966
Cod	Large >72 cm.	21,438	805,592	573,648	1,400,678
	Small I 55—72 cm.	8,789	235,028	141,837	385,654
	Small II 35—55 cm.	4,884	151,239	128,577	284,700
	Small III <35 cm.	458	14,077	22,092	36,627
Total		35,569	1,205,936	866,154	2,107,659
Dab		13,090	102,539	50,915	166,544
Flounder		3,008	6,738	11,061	20,807
Gurnard and Latchet		2,180	131,307	48,367	181,854
Haddock	Large >50 cm.	110	81,936	190,087	272,133
	Large medium 44—50 cm.	38	103,673	234,258	337,969
	Small medium 37—44 cm.	53	175,686	400,551	576,290
	Small I 30—37 cm.	98	115,652	216,476	332,226
	Small II 25—30 cm.	—	45,856	478,712	524,568
	Small III <25 cm.	—	3,060	2,917	5,977
Total		299	525,863	1,523,001	2,049,163
Hake		7	4,558	3,293	7,858
Ling		15	2,001	6,185	8,201
Plaice	Large >50 cm.	—	3,575	—	3,575
	Large medium 40—50 cm.	4,624	250,726	37,367	292,717
	Small medium 35—40 cm.	29,000	768,599	620,804	1,418,403
	Small II 27—35 cm.	87,088	1,055,073	670,278	1,812,439
	Small III 21—27 cm.	65,864	249,834	195,058	510,756
	Small IV <15—21 cm.	93,862	160,078	50,346	304,286
Total		280,438	2,487,885	1,573,853	4,342,176
Saithe		42	1,382	22,141	23,665
Sole	Large >37 cm.	290	5,129	295	5,714
	Large medium 32—37 cm.	5,521	182,729	169,479	357,729
	Small medium 29—32 cm.	7,126	96,566	73,354	177,046
	Small I 26—29 cm.	8,742	39,640	20,241	68,623
	Small II 23—26 cm.	3,255	8,182	1,496	12,933
	Small III 15—23 cm.	646	3,496	1,008	5,150
	Small IV <15 cm.	—	252	—	252
Total		25,580	335,994	265,873	627,447
Turbot		2,799	67,884	93,110	163,793
Whiting		6,711	171,714	879,759	1,058,184
Other species		24,264	129,336	354,202	507,802
Total		397,390	5,193,497	5,711,232	11,302,119

Table 4.

No. of Days Absence or No. of Voyages, total Quantity landed and Quantity per Day Absence of different Types of Vessels fishing from the Port of IJmuiden in 1945

Month of 1945	Steam Trawlers			Motor Luggers (Trawl Fishery)			small Motor Vessels		
	No. of Days Absence	Quantity landed (kg.)	Quantity per Days Absence	No. of Voyages	Quantity landed	Quantity per Voyage	No. of Voyages	Quantity landed	Quantity per Voyage
June	10	53,073	5307	35	183,078	5231	93	74,844	805
July	128	655,410	5120	82	475,982	5805	232	198,700	856
August	279	1,114,333	3994	92	715,305	7775	206	114,204	554
September	222	705,714	3179	68	421,937	6205	183	151,163	826
October	364	1,209,096	3322	39	221,650	5682	483	599,192	1240
November	277	976,286	3525	40	208,258	5206	533	552,335	1036
December	537	1,069,496	1992	39	118,197	3031	94	39,989	425
Total	1817	5,783,408		395	2,344,407		1824	1,730,427	
Mean (1945)			3177			5562			
Mean (1933 and 1934)			1359			2000			

These figures, however, do not refer to the landings at IJmuiden only (like those of 1945) but to the landings at all Dutch ports. But that scarcely interferes with the correctness of the comparison as the ratio between the numbers of the different types of vessels that landed their catch at IJmuiden in 1945 was about the same as that in the whole Dutch fishing fleet in the years 1938 and 1934 [steam trawlers : motor luggers : small motor vessels = 1 : 1.7 : 8.3 (1945); 1 : 1.4 : 8.2 (1938); 1 : 1.4 : 7.1 (1934)].

The increase of the size of the fish caught is very obvious. At IJmuiden are concentrated the largest vessels which fish a good distance from the coast. At Den Helder, however, there is a fleet mainly consisting of small motor vessels for the greater part unfit to fish outside the coastal area. To give an idea of the composition of the stock in this coastal area (Haaks grounds, Egmond grounds) we are giving in Table 6 the quantities landed at Den Helder in some months of 1945 and in Table 7, for plaice and sole, the percentages to the class "small" and the percentage of fishes be-

low 25 cm. The latter figures are based on measurements carried out in 1945. Those of 1938 and 1934 were calculated on the (probably incorrect) assumption that the size distribution of the most common categories "small III" of plaice and "small II" of sole was the same in 1938 and 1945. This is not correct, however, cannot be responsible for the impression given by Table 7 that even when the North Sea stock is very dense the fishing fleet in the Den Helder catches a great quantity of small plaice. The quantity of sole below 25 cm. caught in 1945 was negligible, but we believe that in the summer and early summer many more small soles will be caught in the coastal area.

Table 8 giving the quantities of different species of fish landed during the war and then in 1945 caught in the limited area off our coast and in the Broad Fourteens, reveals some remarkable changes.

Although—as pointed out above—the capacity of the fishing vessels as well as the fishing effort became more and more reduced as the war progressed, the quantity of cod caught by these vessels continued to increase. A great amount of cod, however, was

Table 5.
Percentage of total Quantity landed to the Class "Small".
(1945 — port of IJmuiden, 1938 and 1934 all Dutch Ports).

Month	Cod < 72 cm.			Haddock < 37 cm.			Plaice < 35 cm. < 25 cm.				Sole < 29 cm. < 25 cm.			
	1945	1938	1934	1945	1938	1934	1945	1938	1934	1945	1945	1938	1934	1945
June	40	60	43	30	91	89	88	92	98	37	49	38	48	4.5
July	26	67	71	21	92	89	62	91	96	15	19	56	62	5.5
August	34	65	74	28	88	87	55	94	97	4.5	13	60	61	3
September	45	61	66	39	94	84	61	96	98	6.5	11	62	56	1.2
October	37	50	61	46	93	80	68	92	97	8.5	8	63	55	4
November	30	57	62	42	91	80	54	93	97	2.5	9	56	56	4.5
December	33	67	59	50	90	78	43	87	84	1.6	10	50	53	6.5
Mean	35	61	62	37	91	84	62	92	94	10.8	17	55	56	4.2

Table 6.

Quantities (in Kg.) of Demersal Fish landed in 1945 at the Port
of Den Helder.

Species	Market Categories	Aug.	Sept.	Oct.	Nov.	Dec.
Brill		638	465	382	372	118
Cod	Large	450	—	7,800	—	—
	Small I	—	564	978	35,796	6,486
	Small II	236	120	227	—	—
	Small III	—	80	—	—	—
Total		686	704	9,005	35,796	6,486
Dab		7,369	9,475	14,499	8,699	3,930
Flounder		329	556	564	1,113	860
Plaice	Large and large medium	4,569	1,135	—	—	—
	Small medium	16,573	21,470	30,269	53,591	10,039
	Small II	29,602	36,964	48,501	63,293	19,342
	Small III	29,333	40,813	61,312	27,911	5,072
	Small IV	33,936	25,818	25,414	3,065	676
Total		114,013	126,200	165,496	147,860	35,129
Sole	Large and large medium	6,796	4,363	5,312	6,830	5,093
	Small medium	1,258	2,115	2,061	2,742	1,859
	Small II	288	882	650	720	524
	Small III	507	184	36	108	74
	Small IV	105	294	191	116	83
Total		8,954	7,838	8,250	10,516	7,633
Turbot		817	896	1,145	1,282	670
Whiting		1,673	10,738	86,390	94,440	9,376
Other Species		3,210	1,532	3,911	7,688	891
Total		137,689	158,404	289,644	307,766	65,093

big specimens, were caught near the coast, very
by vessels hardly fit for working at sea.
is no doubt that the cod stock near our
has increased very much. A similar increase
observed after the first world war, but in the
d between 1920 and 1940 the cod stock be-
so intensively fished that regular good
es of cod no longer occurred in the vicinity
e Dutch coast (20 fathom-line).

the end of the first world war together with the
shoals of cod similar shoals of **haddock** ap-
ped near our coast. Now it is very striking that
g the war none of our fishing ships did catch
ock and that in 1945 our trawlers only began
nd haddock when they could visit more north-
grounds like the Cleaver Bank.

Table 7.
Percentage to the Class "Small"
of the total Quantity landed at the Port
of Den Helder in 1945 and 1938.

Month	Plaice				Sole			
	< 35 cm.		< 25 cm.		< 29 cm.		< 25 cm.	
	1945	1938	1945	1938	1945	1938	1945	1938
August	81	99	49	74	10	75	4	47
September	82	97	45	55	17	87	5	75
October	82	98	43	70	11	65	2.5	52
November	64	100	16	85	9	68	1.6	29
December	71	95	13	82	9	67	1.6	16
Mean	76	98	33	73	11	73	3	44

Total Quantities (in Kg.) of Seafood

Period	Brill	Cod			Dab	Flounder	Plaice	
		large	small	total			large and medium	small
1940 Quarter	1st	11,624	564,114	196,747	579,415	115,076	120,587	897,823
	2nd	22,822	202,563	31,942	234,505	454,475	46,481	72,308
	3rd	3,077	—	—	322,391	43,740	2,840	152,590
	4th	742	5	1,457	1,462	769,160	41,331	5,010
Total in 1940		38,265	766,682	230,146	996,828	2,125,441	246,628	200,745
1941 Quarter	1st	10,228	14,095	4,489	18,584	1,384,290	127,088	10,392
	2nd	35,264	2,045	6,122	8,167	1,641,005	58,428	19,425
	3rd	29,215	1,720	5,542	7,262	1,247,689	282,508	26,880
	4th	3,312	11,608	12,741	24,349	1,558,841	50,447	7,451
Total in 1941		78,019	29,468	28,894	58,362	5,831,825	518,525	64,148
1942 Quarter	1st	4,678	79,343	10,570	89,913	1,936,058	214,227	13,514
	2nd	18,721	1,672	3,577	5,249	1,760,851	53,018	8,200
	3rd	13,993	420	2,598	3,018	523,457	52,065	8,338
	4th	703	6,055	9,117	15,172	799,644	15,078	8,350
Total in 1942		38,095	87,490	25,862	113,352	5,020,010	334,288	38,402
1943 Quarter	1st	1,666	12,335	7,301	19,636	666,875	62,448	20,183
	2nd	23,457	5,704	5,939	11,643	651,817	79,375	31,201
	3rd	7,394	2,069	3,970	6,039	212,150	48,421	48,156
	4th	1,119	202,227	61,539	263,766	559,733	6,518	17,426
Total in 1943		33,636	222,335	78,749	301,084	2,090,575	196,762	116,966
1944 Quarter	1st	976	51,449	4,571	56,020	368,597	13,525	20,684
	2nd	9,255	58,963	183,097	242,060	205,033	11,510	116,219
Total in 1944		10,231	110,412	187,668	298,080	573,612	25,035	136,903

During the war the landings of **plaice** increased in spite of the decreasing capacity of the fishing fleet. This gives the impression that the stock of plaice must have increased during the war, an impression which is fully confirmed when one compares the quantity of plaice caught per days absence of Dutch steam trawlers in 1945 (617 kg.) with the mean landing per days absence of the last 10 years before the war (109 kg.).

One gets an entirely different impression when looking over the quantities of **dabs** landed during the war. The total quantities landed decreased from 1941 onwards. Before the war dabs were of very little value and very often a great part of the dabs caught was not brought into the market. But during the war, when people gradually ceased to be particular about edible stuff, all dabs caught were brought into the market. As, therefore, the statistics of the years before this war cannot give a reliable picture of the density of the dab stock we have no pre-war data with which to compare

the present state of the dab stock. We can, however, compare the dab stock with the plaice stock. Then it appears that in 1940, 1941 and 1942 about as many dabs as plaice were landed, but that in 1943 the landings of plaice were about 3 times as big as those of dabs while in 1944 plaice outnumbered dabs in the landings 6 times. In 1938 when a great part of the dabs was not brought into the market about 4.5 times as much plaice as dabs were sold officially. Therefore the true ratio between plaice and dabs must have been less than 4.5, it was probably more equal to the ratio between the landings of plaice and dabs at the end of Den Helder, where there used to be a great demand for dabs, namely a ratio of 2.

So finally there is no doubt that the ratio between the densities of the stocks of plaice and dabs has increased during recent years. The question remains whether this increase is due to a difference in increase of both stocks or an actual decrease of the dab stock combined with an increase of the plaice stock.

Markets during the War.

Sole			Turbot	Whiting	Other Species	Total	Period	
medium	small	total					Quarter	
3,282	93,831	163,018	37,920	812,003	3,074,499	6,572,862	Quarter	1st 1940
3,907	200,516	397,402	63,763	691,421	1,546,500	4,808,925		2nd
1,135	19,303	23,438	973	41,905	8,952	599,906		3rd
379	306	685	172	650,350	16,373	1,546,100		4th
0,893	313,956	584,542	132,828	2,195,679	4,646,324	13,527,757	Total in 1940	
0,954	29,028	40,724	1,337	1,046,900	238,788	3,568,526	Quarter	1st 1941
8,839	42,853	64,713	11,391	494,227	403,297	4,098,076		2nd
9,183	143,575	174,705	29,190	800,470	392,352	4,770,933		3rd
7,509	16,885	24,882	9,451	1,554,974	1,261,136	5,128,659		4th
5,485	232,340	305,024	51,369	3,896,571	2,295,573	17,566,194	Total in 1941	
2,014	7,063	9,077	2,901	1,094,058	65,295	5,306,898	Quarter	1st 1942
0,523	29,969	42,737	6,364	420,864	71,939	4,047,881		2nd
3,137	67,283	70,683	13,838	39,134	170,336	1,619,550		3rd
757	4,129	4,913	2,758	1,012,373	472,848	2,575,348		4th
5,431	108,444	127,410	25,861	2,566,429	780,448	13,549,677	Total in 1942	
674	914	1,672	1,400	28,557	286,914	3,188,220	Quarter	1st 1943
2,751	26,809	29,640	8,862	26,139	356,521	3,340,911		2nd
5,883	45,014	51,901	8,693	408,444	449,445	2,156,427		3rd
567	1,214	1,781	4,911	601,513	175,011	2,230,464		4th
8,875	73,951	84,994	23,866	1,064,653	1,267,891	10,916,022	Total in 1943	
20	130	157	571	1,994	193,500	1,499,140	Quarter	1st 1944
3,552	13,622	61,491	14,100	102,554	53,301	3,286,139		2nd
3,572	13,752	61,648	14,671	104,548	245,801	4,785,279	Total in 1944	

From the landings per days absence of steamers in 1938 and 1945 we should conclude that density of the plaice stock near our coast has increased more than 5 times. The ratio between landings of plaice and dabs has increased at 3 and at the most 6 times. There is therefore no reason to suppose that the dab stock has increased, most likely it has increased too, but much smaller extent than the stock of plaice. The landings of sole have also decreased in years. As, however, at the resumption of fishery in 1945, very good catches of sole made and the ratio of the landings of plaice and sole of sole remained almost the same (7.6 in 1938 and 8.2 in 1945) we are apt to think that the stocks of plaice and of sole have increased proportionately. The decrease in the landings of sole are probably due to the prohibition of the fishery in July 1942.

The last interesting fact that remains to be mentioned here is that during the later years of

the war an increase of the **horse-mackerel** was observed near our coast. In July 1944 and 1945 big shoals of large horse-mackerels were sometimes reported from pools on the beach, hunting for young herring. Dr. J. Verwey, the director of the Zoological Station at Den Helder told me that during the spring of 1944 and 1945 the horse-mackerel had probably spawned in the Wadden-sea, a phenomenon not observed before.

In judging the value of the data given here the reader must understand that we have not yet been able to investigate the changes that have occurred in the stocks as thoroughly as we should like. So all that has been said above has a more or less premature character, the chief aim being to inform other workers of the impressions we have in our mind at the moment, impressions which we should like to exchange with our colleagues in order to improve our general understanding of the situation.

England

The Rye Bay Plaice Stock in the War of 1939—45.

By

R. S. Wimpenny.

THE inshore fisheries of the south-east coast include a variety of methods from lobster-potting on the West Sussex coast to stow-netting in the Thames, but with one device or another the fishermen manage to work throughout the year. The most widespread and important gear used is the trawl, and observations taken as a result of the war-time control of fishing boats showed that the catch per hour was greatest in the coastal area of Rye Bay, where the Channel commences to become narrow and the trawl is the only fishing gear used. Rye Bay has always had the reputation of being a good fishing ground to which inshore fishermen from as far west as Shoreham, and as far east as Folkestone, had been in the habit of resorting in the spring and summer of pre-war years. In those days, however, many of the fishermen who have recently made a rich living were receiving public assistance, and the catches obtained were low.

One of the principal constituents of the inshore catch is the plaice, which is particularly important in Rye Bay, where it has a favourite ground of 10—12 fathoms of water, stretching from ten miles south-east of Dungeness to between five and seven miles south of Hastings. It is known by fishermen as "the Trail". (Fig. 1).

During the course of the war the fishery in this ground became exceedingly good and it was prosecuted by increasing numbers of boats. At this period I was responsible for the issue of permits to fishing boats in this area and I received repeated complaints from fishermen that too many boats were being allowed to work on the ground and that if I did not restrict the number the fishery would be ruined. In view of the complete cessation of fishing in the neighbouring deeper waters and because I thought the Rye Bay plaice likely to be a migratory portion of the deeper water stock, I was not of this opinion. However, a



Fig. 1.
The South East Coast
of England showing
the Rye Bay
Trawling Ground.

[illegible]

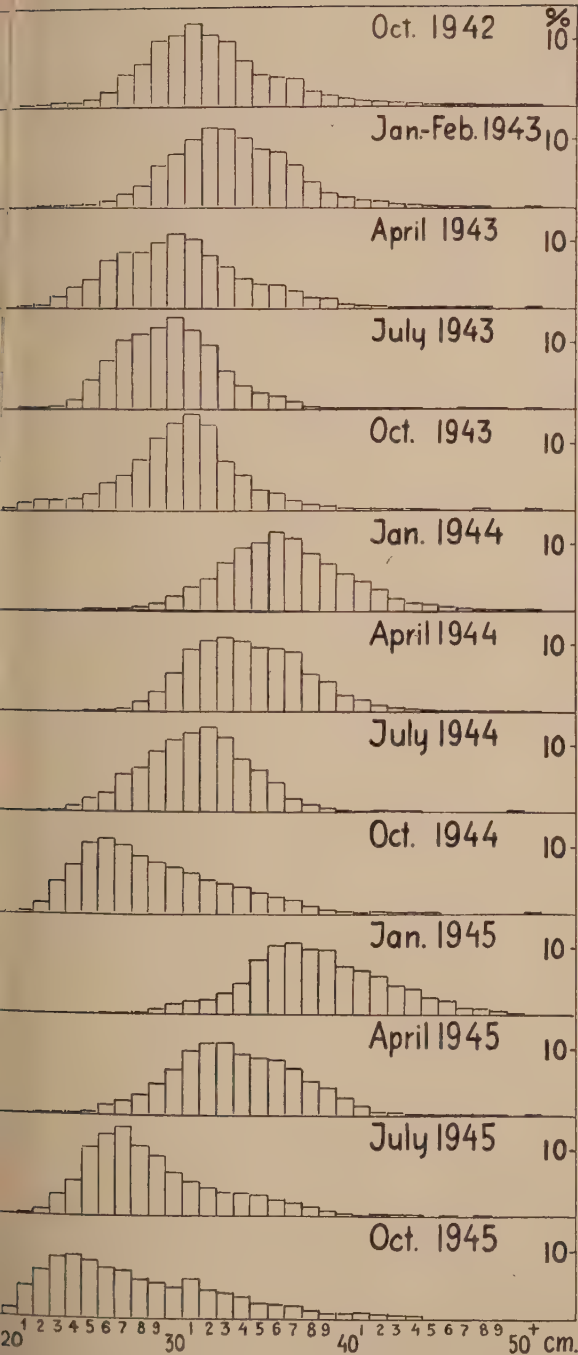


Fig. 2 Frequency Histograms showing the Length Distribution of Rye Bay Plaice each Quarter from October 1942 to October 1945.

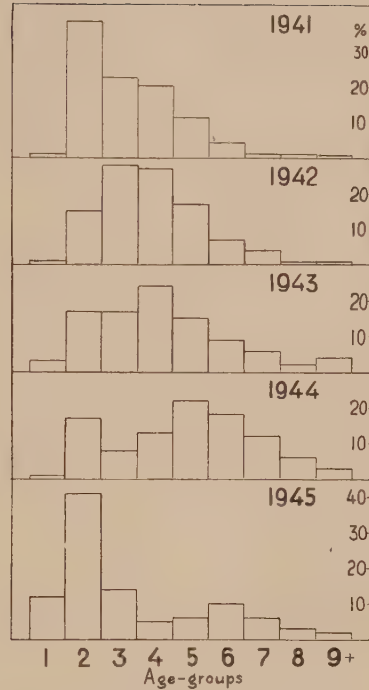


Fig. 3. Percentage Age-Distribution of Rye Bay Plaice for years 1941 to 1945.

order to deal with the local situation in a more authoritative way, and also on account of its importance in relation to the wider question of the rational control of fishing, I started to collect a limited amount of information on the size and age-composition of the plaice stock to see whether any changes were taking place in the characters that might indicate the greater or lesser effect of fishing.

Size and Age of the Commercial Catch.

It was apparent that the size of Rye Bay plaice underwent a seasonal variation, larger fish coming inshore in the winter, but precise observations on the degree of this variation and the differences between years were lacking. The measurement of about 3000 fish as landed in the commercial catch at Rye and Hastings each quarter was therefore begun in October 1942. (Table 1).

The length frequencies are given in Figure 2, and they show that each year the longest fish occurred in the winter quarter, and that these were succeeded in the summer and autumn by smaller individuals. As the observations went on, the range of size became greater owing to the increasing length of the winter fish, while the summer and autumn samples included some individuals that were smaller than those found in the preceding season. Most of the large fish that occurred in the winter quarter (January) were spent mature individuals, and it is notable that they were often caught within a few hundred yards of the beach, while "the Trail" was populated by smaller ones. In each year the smallest fish were found in the autumn (October) quarter. It is clear from these results that the stock of fish on these grounds changes from season to season.

To gain an idea of the age-composition of the stock four stones of plaice from the Rye commercial catch were measured, weighed and examined for age by otolith readings each month

from February 1941 up to the present, the results dealt with here being until the end of 1945. In January 1942 these fish were from sample mixed sizes not sorted into categories. Up to the end of 1941, however, plaice at Rye and Hastings were sorted into three categories, "Large and Heavy", "Fryers", and "Stocker", and the samples were made up of roughly equal weights of the two categories. The category "Stocker" was rejected because it included the very small fish which were only occasionally landed by some boats. After 1941 the fish dealt with were "as caught" commercial samples landed by trawlers, the majority of whose cod-ends did not exceed 30 rows to the yard.

The reading of the otoliths was difficult, I found that I could only accept about 70% of them with certainty, the rest being doubtful on account of unusually thick, split or incomplete white rings which could not be interpreted. The doubtful examples I put down as "query" values, never the value might be. On plotting these against the certain determinations, and comparing them with the certain determinations plotted alone, I found that the resultant histograms did not differ very much, and for this reason I think that the selection of readable otoliths has not produced a sufficient bias to affect the deductions.

The year-groups revealed by this material are shown in Figure 3 and Table 2. They are notable for three things. In the first case, and in accordance with all that a fishery research worker

Table 2.
Age-Group Distribution as Numbers, Percentages, Mean Lengths and Standard Deviations of Lengths for Commercial Catch of Rye Bay Plaice in different Years

Age-groups	I	II	III	IV	V	VI	VII	VIII	IX
1941 Number	5	390	227	202	125	41	8	3	3
%	1	38	22	20	12	4	1	1	1
Mean length (l.)	25.1	27.6	27.5	29.0	30.0	31.9	34.4	37.2	
$\sigma \cdot l.$		3.0091	2.8718	3.2950	3.3759	4.5883	3.6031		
1942 Number	6	92	183	171	108	46	28	6	4
%	1	14	28	27	17	7	4	1	1
Mean length (l.)	23.5	29.0	29.8	30.7	32.2	35.6	36.6	41.0	
$\sigma \cdot l.$	2.0000	2.8879	3.1965	3.0401	3.3963	4.3990	4.5373		
1943 Number	17	103	101	147	93	59	37	15	2
%	3	17	17	25	16	10	6	2	4
Mean length (l.)	23.0	27.4	30.0	31.0	33.5	35.4	37.2	39.9	
$\sigma \cdot l.$	1.2805	3.1935	3.7513	3.4329	3.4196	3.4053	4.8584	3.0190	
1944 Number	4	88	41	68	111	92	64	31	6
%	1	17	8	13	22	18	12	6	3
Mean length (l.)	22.5	28.6	31.5	32.9	33.8	36.1	37.4	38.8	
$\sigma \cdot l.$		3.1774	3.2364	3.1543	3.1800	3.7109	3.0514	3.8468	
1945 Number	88	292	103	34	47	75	45	24	2
%	12	41	14	5	7	10	6	3	2
Mean length (l.)	23.1	26.3	31.5	33.0	34.6	36.4	38.4	38.7	
$\sigma \cdot l.$	1.4212	3.1536	3.9169	2.9153	2.8740	3.7729	2.6648	2.7923	

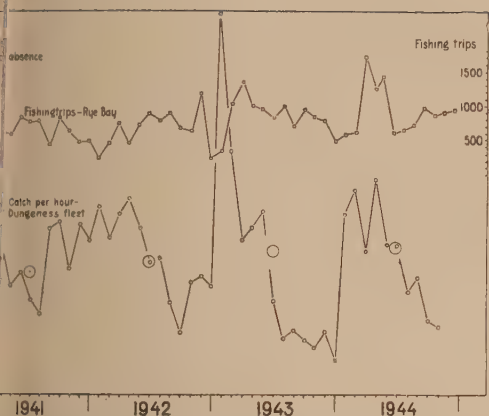


Fig. 4. Above, Number of Fishing Boat Trips made in Rye Bay each Month. Below, Catch in Stones and Pounds "per Absence from Port" of Dungeness Motor Trawlers.

ct, there is a progressive increase in the importance of the older year-groups up to 1944. Only a strong II-group appears in 1941 and is apparent as a year-group of unusual importance in 1945. This points to a specially successful survival in 1939. Finally in 1945 the older groups became less important and strong I and II-groups appeared.

The first observation is clearly the result of cessation of offshore fishing, and indicates that there was no evidence of over-fishing in the Rye Bay area during the war, while the second shows that great changes in stock composition may occur as a result of natural fluctuations, and that it is of substantial importance to identify these and to rely for them in making estimates of the present state of the fishery. The significance of the first observation is more speculative. Are the strong I and II-groups natural fluctuations in the stock that they owe their origin to favourable conditions of survival, or are they the progeny of the strong 1939 group which, as the IV-group of 1943 and the V-group of 1944, might be expected to have spawned vigorously under the favourable conditions of war-time protection?

Naturally there is not much evidence as to the relative strength, growth and survival of fish

broods elsewhere, but it is to be noted that Vedel Tåning (1) refers to the fact that 1939 was exceptional in the Iceland area on account of the warmth and salinity of the water. Halibut, cod and haddock broods grew well in this area. The only information about the 1939 plaice brood elsewhere than Rye Bay is from Danish waters, where, according to Blegvad (2) the 1939 year-class was above normal in the Skagerrak, but below in all other areas except the West Baltic. The temperature of these Danish waters was also above normal. Further evidence on this matter will, no doubt, emerge from the age-determination of fish populations that are at present being made or that await publication.

Before leaving a consideration of the year-groups it should be pointed out (Table 2) that there is an indication of an increase in length from year to year to which it is hoped to pay further attention in a later paper.

The Intensity of Fishing.

One of the requirements of war-time control produced a record of the number of fishing boat trips made each day in Rye Bay, and from the petrol rationing scheme there are available logs giving the total catch and the time at sea for each fishing trip. From these data it is possible to give the number of boats at sea each month, and the average catch per hour, of the motor trawlers working from the different Rye Bay fishing stations. These figures are given in Tables 3 and 4, and are shown graphically in Figure 4, where the "catch per hours absence from port" of Dungeness motor trawlers is compared with the number of fishing boats at work. Dungeness has been chosen as representative of the Rye Bay fishing boats partly because the records extend over a longer period than elsewhere, and partly because the boats were identical over the period and suffered virtually no alterations.

It will be seen that there was a steady augmentation in the number of fishing trips made throughout the period 1941—1944. This change in fishing intensity is actually greater than it appears, as the increase was largely due to the fitting out of new and larger boats at Rye — a place that began the war as an insignificant fishing station and

Table 3.

Number of Day Fishing Trips made by Motor Trawlers working from all Rye Bay Fishing Stations.

Months	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1941	—	—	622	594	826	769	783	421	808	678	470	468
1942	228	437	747	448	727	891	765	890	659	615	1173	206
1943	342	1019	1419	995	938	802	983	675	910	810	789	464
1944	554	576	1796	1241	1321	593	645	717	958	841	883	913

Table 4. Catch per Hours Absence from Port in Stones and Pounds for Trawlers of Rye Bay Fishing Stations.

Months	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Mean.
1941													
R		6—11 $\frac{3}{4}$				6—11 $\frac{1}{4}$	3—9 $\frac{3}{4}$	8—8					
D		3—4	3—2	2—3 $\frac{3}{4}$	2—7 $\frac{1}{2}$	1—13 $\frac{1}{4}$	1—9 $\frac{1}{2}$	3—6 $\frac{1}{4}$	3—8 $\frac{3}{4}$	2—8 $\frac{1}{2}$	3—7 $\frac{1}{4}$	3—23 $\frac{3}{4}$	5—12 $\frac{1}{2}$ 2—7 $\frac{3}{4}$
1942													
H			5—03 $\frac{3}{4}$	4—13 $\frac{1}{4}$	6—43 $\frac{3}{4}$			2—0	1—41 $\frac{1}{2}$	2—0 $\frac{1}{2}$	2—2	2—01 $\frac{1}{2}$	2—01 $\frac{1}{2}$
R	1—43 $\frac{3}{4}$	2—43 $\frac{3}{4}$			3—6 $\frac{1}{4}$	3—41 $\frac{1}{4}$	3—61 $\frac{1}{4}$	2—9 $\frac{1}{2}$	1—121 $\frac{1}{2}$	2—121 $\frac{1}{4}$	2—31 $\frac{1}{2}$	1—103 $\frac{3}{4}$	2—6
D	3—123 $\frac{3}{4}$	3—33 $\frac{3}{4}$	3—103 $\frac{3}{4}$	4—1	3—6 $\frac{1}{4}$	2—11	2—113 $\frac{3}{4}$	1—121 $\frac{1}{2}$	1—33 $\frac{3}{4}$	2—41 $\frac{1}{2}$	2—61 $\frac{1}{4}$	2—31 $\frac{1}{4}$	2—103 $\frac{3}{4}$
1943													
H	5—11 $\frac{1}{4}$	3—123 $\frac{3}{4}$	2—81 $\frac{1}{4}$	2—9	2—113 $\frac{3}{4}$	1—23 $\frac{3}{4}$	1—91 $\frac{1}{4}$	1—61 $\frac{1}{2}$	1—5	1—6	1—73 $\frac{3}{4}$	1—7	2—23 $\frac{3}{4}$
R	3—6	4—03 $\frac{3}{4}$	3—93 $\frac{3}{4}$	4—51 $\frac{1}{4}$	3—51 $\frac{1}{4}$	2—41 $\frac{1}{2}$	2—13 $\frac{3}{4}$	2—13 $\frac{3}{4}$	1—53 $\frac{3}{4}$	1—5	1—133 $\frac{3}{4}$	1—81 $\frac{1}{4}$	2—11
D	7—121 $\frac{1}{2}$	5—1	3—3	3—61 $\frac{1}{2}$	3—111 $\frac{1}{4}$	1—13	1—21 $\frac{1}{4}$	1—41 $\frac{1}{4}$	1—13 $\frac{3}{4}$	0—131 $\frac{1}{2}$	1—4	0—93 $\frac{3}{4}$	2—133 $\frac{3}{4}$
1944													
H	3—103 $\frac{3}{4}$	5—03 $\frac{3}{4}$	4—61 $\frac{1}{2}$	4—4	2—23 $\frac{3}{4}$	2—71 $\frac{1}{2}$	1—51 $\frac{1}{4}$	1—111 $\frac{1}{2}$	1—10	2—1	1—9	2—01 $\frac{1}{2}$	2—101 $\frac{1}{4}$
R	5—01 $\frac{1}{2}$	3—13 $\frac{1}{2}$	4—71 $\frac{1}{2}$	5—43 $\frac{3}{4}$	3—121 $\frac{1}{4}$	3—10	3—11 $\frac{1}{2}$	3—11 $\frac{1}{2}$	1—133 $\frac{3}{4}$	1—111 $\frac{1}{4}$	1—31 $\frac{1}{2}$	1—13 $\frac{3}{4}$	3—9
D	3—101 $\frac{1}{2}$	4—31 $\frac{1}{4}$	2—131 $\frac{1}{2}$	4—61 $\frac{1}{2}$	3—11 $\frac{1}{2}$	3—1	2—13 $\frac{3}{4}$	2—53 $\frac{3}{4}$	1—71 $\frac{1}{4}$	1—51 $\frac{1}{4}$			3—01 $\frac{1}{4}$

D = Dungeness; H = Hastings; R = Rye.

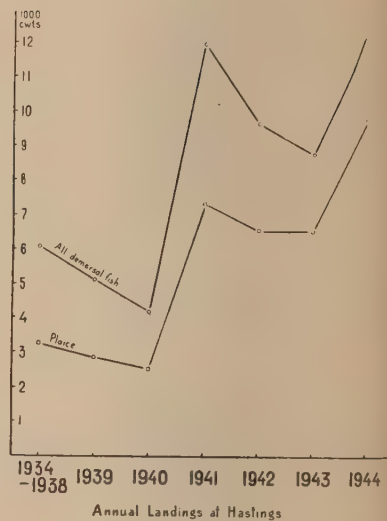


Fig. 5. Landing of all Demersal Fish and of Plaice at Hastings for Average of Period 1934—38, and each year from 1939 to 1944.

ended with a fleet of 100 boats, including number of 1st class vessels. In spite of this increased intensity of fishing the "catch per hour" for demersal fish (which were largely plaice) has not fallen but has actually increased throughout the period discussed.

The Commercial Landings.

The total landings from the Rye Bay ground also increased during the war both in respect of total demersal fish and of plaice. (Table 5.) The state of affairs at Hastings may be taken as most representative because a considerable fishery with similar men and methods had been carried on there for many years before 1939 and remained much the same throughout the war. The Hastings landings (Figure 5) show a fall through 1939 to 1940 from the average of the years 1934—38. It is likely that much, if not all, this fall was due to the disturbance to the fishermen caused by the outbreak of war and the calling up of Naval Reserve men in 1939, and the evacuation from the kirk and the subsequent partial evacuation of the stings in the precarious year that followed.

In 1941 the catch rose to a new higher level which remained of the same order for all demersal fish for the rest of the period, but showed a further increase in 1944 for plaice.

In view of the observations just given, the information on the distribution of the age-groups and the fact that from June 1940 until the end of the conditions of war-time control remained virtually the same, I think it justifiable to conclude that the increased yield taken from the fishery

Table 5.
Landings of Plaice at Hastings.

And below (a) Plaice. (b) all Demersal Fish at Rye Bay Ports.

	1934—1938	1939	1940	1941	1942	1943	1944
	cwt (0/0)	cwt (0/0)	cwt (0/0)	cwt (0/0)	cwt (0/0)	cwt (0/0)	cwt (0/0)
January							
Large	31 (18)	31 (16)	14 (21)	22 (22)	24 (22)	200 (31)	162 (21)
Medium	77 (46)	94 (49)	36 (54)	55 (54)	61 (57)	333 (51)	480 (61)
Small	61 (36)	68 (35)	17 (25)	25 (24)	22 (21)	114 (18)	140 (18)
February							
Large	39 (16)	34 (16)	63 (18)	61 (16)	164 (23)	278 (25)	223 (19)
Medium	110 (44)	101 (47)	187 (52)	178 (46)	434 (60)	593 (52)	697 (61)
Small	100 (40)	78 (37)	107 (30)	147 (38)	121 (17)	260 (23)	225 (20)
March							
Large	43 (12)	56 (16)	51 (18)	74 (13)	194 (18)	275 (20)	443 (20)
Medium	153 (42)	168 (47)	136 (48)	258 (44)	585 (55)	711 (52)	1254 (56)
Small	164 (46)	133 (37)	94 (34)	254 (43)	282 (27)	374 (28)	542 (24)
April							
Large	41 (12)	55 (15)	47 (15)	73 (13)	105 (16)	177 (18)	292 (16)
Medium	144 (43)	176 (47)	148 (48)	255 (44)	359 (55)	554 (55)	1037 (58)
Small	154 (45)	140 (38)	114 (37)	253 (43)	192 (29)	272 (27)	477 (26)
May							
Large	39 (12)	59 (14)	60 (15)	113 (11)	147 (20)	128 (16)	164 (14)
Medium	136 (41)	193 (48)	192 (48)	441 (44)	390 (52)	430 (55)	652 (58)
Small	159 (47)	153 (38)	149 (37)	451 (45)	210 (28)	222 (29)	318 (28)
June							
Large	28 (11)	31 (15)	32 (16)	84 (11)	121 (15)	38 (15)	76 (15)
Medium	102 (41)	105 (51)	96 (48)	322 (43)	462 (56)	138 (55)	279 (56)
Small	121 (48)	69 (34)	71 (36)	345 (46)	241 (29)	74 (30)	145 (29)
July							
Large	33 (11)	27 (16)	41 (14)	71 (11)	104 (15)	82 (17)	36 (15)
Medium	125 (40)	83 (48)	137 (45)	267 (42)	399 (56)	278 (56)	142 (57)
Small	155 (49)	62 (36)	125 (41)	301 (47)	203 (29)	132 (27)	70 (28)
August							
Large	42 (11)	48 (16)	39 (14)	47 (12)	83 (14)	28 (16)	66 (15)
Medium	161 (40)	145 (49)	122 (45)	164 (42)	358 (59)	100 (58)	250 (57)
Small	196 (49)	106 (35)	110 (41)	177 (46)	160 (27)	46 (26)	120 (28)
September							
Large	33 (12)	54 (16)	23 (17)	189 (14)	39 (18)	45 (17)	56 (16)
Medium	112 (41)	165 (51)	63 (47)	555 (43)	126 (57)	151 (58)	205 (57)
Small	129 (47)	106 (33)	48 (36)	556 (43)	55 (25)	65 (25)	95 (27)
October							
Large	32 (13)	36 (16)	5 (23)	141 (16)	54 (19)	42 (17)	72 (14)
Medium	102 (42)	114 (51)	11 (50)	445 (52)	158 (56)	148 (58)	306 (58)
Small	108 (45)	75 (33)	6 (27)	280 (32)	69 (25)	63 (25)	149 (28)
November							
Large	30 (13)	14 (16)	16 (18)	99 (21)	111 (21)	31 (19)	44 (15)
Medium	97 (43)	47 (53)	45 (50)	246 (54)	284 (53)	92 (58)	176 (58)
Small	98 (44)	28 (31)	29 (32)	113 (25)	136 (26)	36 (23)	82 (27)
December							
Large	13 (16)	5 (17)	15 (16)	42 (17)	21 (20)	17 (22)	38 (14)
Medium	38 (46)	15 (52)	46 (47)	139 (58)	61 (58)	44 (58)	150 (58)
Small	32 (38)	9 (31)	36 (37)	61 (25)	23 (22)	15 (20)	70 (28)
(a)	4,044	4,561	5,588	14,870	14,103	12,977	19,428
(b)	7,614	7,367	8,228	23,116	21,278	21,446	23,175

Table 6.

Theoretical Relation between Length and Weight ($W=CL^n$) for different Year-Class of gutted Rye Plaice weighed in ounces.

Age-Group	1942	1943	1944	1945
II	$W=0.000274 L^{3.595}$	$W=0.0000163 L^{4.146}$	$W=0.0000198 L^{4.217}$	$W=0.0000139 L^{4.217}$
III	$=0.000773 L^{3.909}$	$=0.0000153 L^{4.106}$	$=0.000182 L^{3.498}$	$=0.0000146 L^{3.498}$
IV	$=0.000332 L^{3.657}$	$=0.000992 L^{3.966}$	$=0.0000239 L^{4.216}$	$=0.000290 L^{4.216}$
V	$=0.000711 L^{3.876}$	$=0.000964 L^{3.949}$	$=0.0000139 L^{4.059}$	$=0.00248 L^{4.059}$
VI	$=0.000110 L^{3.344}$	$=0.000871 L^{3.911}$	$=0.000292 L^{3.600}$	$=0.000214 L^{3.600}$
VII	$=0.00939 L^{3.281}$	$=0.000334 L^{3.651}$	$=0.000734 L^{3.832}$	$=0.00169 L^{3.832}$
VIII	$=0.000143 L^{3.362}$	$=0.000151 L^{3.407}$	$=0.000137 L^{3.388}$	$=0.00643 L^{3.388}$

had not exceeded the maximum it was capable of sustaining in 1944 in spite of the increasing fishing effort.

The commercial catch of plaice at Hastings is separated into "Large", "Medium" and "Small" categories, and these show certain features of interest which emerge from an inspection of Table 5. In the first case the proportion of large fish increased and that of small fish diminished each winter; secondly, there was an unusually large proportion of small plaice in 1941, the year in which, it will be recalled, there had been an unusually large II-group in the material used for age-determination.

The Relation between Weight and Length.

The reduction of fishing in the offshore waters of the North Sea and its cessation in the offshore waters of the English Channel would naturally be expected to result in the increased abundance of plaice that, in fact, happened in inshore waters. It occurred to me that, as a consequence of this, there might have been sufficient over-crowding to have reduced the average weight of the fish, and that this might emerge from a comparison of weight and length. Accordingly this relation was calculated for the II to VII-group fish of the different years, employing the formula ($W=CL^n$) used by Raïtt (3). The results are given in Table 6.

The figures showed to my surprise, that there was a tendency for weight to increase relatively to the length from 1942 to 1944, but that in 1945 there was a decrease in this relation. The

series of figures showing the power (n) by which length was related to weight for the different year groups were tested by the " t " test of Fisher to find out what significance, if any, there was between successive years. On doing this it was found that between 1942 and 1943 the value of " t " obtained by calculation — 3.793 — would only occur by chance less than once in a hundred times, and that the difference was a significant one. Between 1943 and 1944 ($t=0.405$) there was no significant difference and between 1944 and 1945 ($t=1.639$) the difference might have occurred by chance less than once in five times, and was, therefore, of only limited significance.

The fact that the only substantial difference that took place from one year to another was an increase in the relation between weight and length shows that such over-crowding as had taken place had not caused any decrease in the amount of food available for the individual fish, but rather indicated an increase. In 1945, however, it is possible that competition for food may have resulted in loss of weight. If this is so the small I and II-groups of that year suggest themselves as effective agents.

Literature.

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2. Blegvad, H., *ibid.*, p. 149.
3. Raïtt, D., Fisheries, Scotland, Sci. Invest., 1932, p. 26 (1933).
4. Fisher, R. A., "Statistical Methods for Research Workers", p. 115, 151 (London, 1932).

Revised Table 6 to replace table printed above.

Age-Group	1942	1943	1944	1945
II	$W=0.0000365 L^{3.595}$	$W=0.00000612 L^{4.146}$	$W=0.00000506 L^{4.217}$	$W=0.00000720 L^{4.217}$
III	$=0.0000129 L^{3.909}$	$=0.00000653 L^{4.106}$	$=0.0000550 L^{3.498}$	$=0.00000687 L^{3.498}$
IV	$=0.0000302 L^{3.657}$	$=0.0000101 L^{3.966}$	$=0.00000419 L^{4.216}$	$=0.0000345 L^{4.216}$
V	$=0.0000141 L^{3.876}$	$=0.0000104 L^{3.949}$	$=0.00000719 L^{4.059}$	$=0.000402 L^{4.059}$
VI	$=0.0000910 L^{3.344}$	$=0.0000115 L^{3.911}$	$=0.0000342 L^{3.600}$	$=0.0000467 L^{3.600}$
VII	$=0.000106 L^{3.281}$	$=0.0000299 L^{3.651}$	$=0.0000136 L^{3.832}$	$=0.000591 L^{3.832}$
VIII	$=0.0000700 L^{3.362}$	$=0.0000660 L^{3.407}$	$=0.0000727 L^{3.388}$	$=0.000156 L^{3.388}$

que

La campagne du hareng guai 1944—45

(Résumé du rapport Néerlandais "Yle-haringcampagne 1944—45").

Par

Ch. Gilis.

A. Exploitation.

ou et époque de pêche.

e même que les campagnes précédentes, les de harengs guais se concentrèrent principalement sur le littoral belge. Ils se déplacèrent de est vers l'Est et les dernières captures furent dans les environs du bateau phare "Wandelaar". C'est à cet endroit que disparurent brusquement les bancs de harengs, disparition qui signala la fin de la quatrième campagne de harengs depuis la guerre et qui furent toutes d'une durée vraiment miraculeuse.

La campagne 1944—45 débuta le 11 décembre et finissa le 28 février 1945. La durée de la campagne comparée à celle des trois campagnes précédentes, lesquelles durèrent toutes plus de 80 jours, fut de courte durée, puisqu'elle ne se prolongea pas au delà de 80 jours.

ports, flottilles de pêche, personnel et méthode de pêche.

Les ports étant gravement endommagés par les opérations de guerre, seul le port de Dunkerque fut utilisable, au moment que les premiers bancs de harengs guais firent leur apparition sur la côte belge. Le port d'Ostende resta d'usage pour la pêche jusqu'au 12 décembre, de Blankenberghe jusqu'au 17 décembre, et de Zeebrugge jusqu'au 6 janvier. Par suite de graves explosions qui se produisirent dans le port d'Ostende, à la date du 15 février, une partie de la flottille Ostendaise resta bloquée dans le port, jusqu'à la fin de la campagne harenguière. L'exploitation des bancs de harengs en fut grandement gênée.

Le port de Dunkerque étant toujours occupé par l'ennemi durant l'hiver 1944—45, les Belges ne purent, comme les années précédentes, rallier le port Français. Les Français encore plus gênés nous par cette occupation prolongée vinrent solliciter notre hospitalité et 25 bateaux français vinrent s'installer à Nieuport pour la durée de la campagne harenguière, d'où ils pratiquèrent la pêche dans nos eaux.

Sur le côté belge 280 chaloupes prirent part à l'exploitation des bancs de harengs guais. Au to-

tal 1,480 hommes d'équipage furent enrolés à cet effet.

La force motrice moyenne de ces 280 bateaux était de 50.4 HP. (en 1943—44: 337 bateaux de 44 HP, en 1942—43: 290 bateaux de 32 HP.)

Toute la flottille a employé exclusivement le chalut à panneaux (Otter trawl).

III. Nombre de pêches et apports.

Pendant la campagne harenguière 1944—45 les bateaux belges débarquèrent 3,889 pêches d'un poids total de 31,846,602 kg.

Le poids débarqué par la flottille française s'éleva à 2,692,623 kg. (pour plus amples détails voir tableau I).

Tableau I.
Campagne de harengs guais 1944—45:
Apports.

Mois	Nombre de navires	Nombre de pêches	Poids total débarqué
Décembre	197	990	6,239,199
Janvier	256	1,586	11,612,410
Février	264	1,313	13,994,993
Total		3,889	31,846,602

En comparant les résultats de cette campagne avec ceux de la précédente (voir tableau II) nous constatons une forte diminution 1°) du nombre des captures : 3,889 contre 9,379, soit 5,490 captures ou 59 %; 2°) du poids débarqué : 31,846,602 kg. contre 58,119,500 kg., soit 26,272,898 kg. ou 45 %.

Tableau II.
Récapitulation des résultats des 4 dernières campagnes.

Campagnes	Nombre de pêches	Poids débarqué	Moyenne par pêche Poids (kg.)
1941—42	2,383	10,006,791	4,199
1942—43	9,165	51,894,746	5,662
1943—44	9,379	58,119,500	6,197
1944—45	3,889	31,846,602	8,189
Total	24,816	151,867,639	6,119

D'après les données du tableau II, deux chiffres records furent atteints en 1943—44 : celui du nombre de pêches (9,379) et celui du poids débarqué (58,119,500 kg.). Le record du poids moyen par pêche fut enlevé en 1944—45 avec 8,189 kg.

Moyenne de la production saisonnière:

1) par navire: 112,306 kg. 1943—44=181,601 kg.; 1942—43=178,947 kg.

2) par unité d'équipage: 21,247 kg. 1943—44: 42,704 kg.; 1942—43: 47,829 kg.

IV. Densité de la concentration 1944—45.

D'après les résultats mentionnés dans la col. 4 du tableau II, le poids moyen par journée de pêche augmenta de saison à saison et en 1944—45 cette augmentation fut la plus forte 8,189 kg. contre 6,197 kg. en 1943—44, soit 24 0/0.

Cette appréciable augmentation de la capture moyenne par journée de pêche est surtout le résultat de la densité de la concentration harenguière plus forte qu'en 1943—44; en effet, pendant cette dernière campagne la capture moyenne pour une unité de HP développée atteignit 130 kg. de harengs, contre 160 kg. en 1944—45.

B. Etude biologique et biométrique de la concentration 1944—45.

Pendant les 53 jours de pêche effective de la campagne 1944—45, il a été prélevé 22 échantillons de 25 harengs chacun soit au total 550 individus. Comme précédemment, les analyses ont porté sur: 1° la taille, 2° le poids, 3° le sexe, 4° le stade des gonades, 5° la quantité de graisse mésentérique, 6° l'âge, 7° le nombre de vertèbres et 8° le contenu stomacal.

1° Taille. — La taille variait entre 20 et 29 cm. La taille moyenne fut portée à 25.20 cm. contre 25.76 cm. en 1943—44; 25.43 cm. en 1942—43 et 24.50 cm. en 1941—42.

Tableau III.

Fréquence et pourcentage de chaque taille.

Taille en cm.	Nombre d'indiv.	Pourcentage
20.	4	0.7
21	16	2.9
22	25	4.5
23	27	4.9
24	62	11.3
25	145	26.4
26	177	32.2
27	74	13.5
28	19	3.4
29	1	0.2

2° Poids. — Les 550 harengs soumis à l'analyse pesaient ensemble 55.075 kg., soit en moyenne 100 gr. ou 10 individus au kilo. En 1943—44 cette moyenne fut portée à 108 gr. ou 9.26 individus au kilo. En 1942—43 à 101 gr. ou 9.9 individus au kilo et en 1941—42 à 89.50 gr. ou 8.12 individus.

La légère diminution de la taille moyenne du poids moyen de l'individu par rapport à l'année 1943—44 s'explique par une faible diminution des vieilles classes de recrutement 1936, 1935, 1934, constatée plus loin.

3° Sexe. — L'analyse du sexe donne 287 mâles 52.2 0/0 et 263 femelles ou 47.8 0/0.

4° Stade des Gonades. — Parmi les 550 harengs 548 avaient les gonades vides ou guais et étaient déjà en travail de réfection (= stade VIII — IX). D'un mâle les gonades étaient bouvardes (= stade VI) et les gonades d'une femelle contenaient encore quelques résidus d'ovaires (= stade VII).

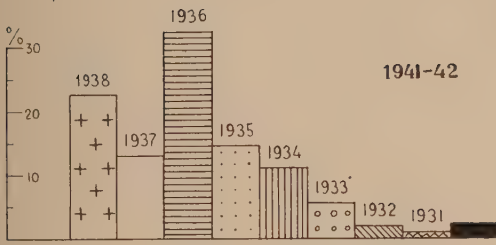
5° Quantité de graisse mésentérique. — 275 individus soit 50 0/0 des harengs analysés ne montraient plus aucune trace de graisse mésentérique (=0); 272 harengs soit 49.5 0/0 montraient une mince filette de graisse (=1). Un avec assez beaucoup de graisse (=+) et un avec beaucoup de graisse (=M). Ces résultats démontrent que la composition était à deux exceptions près, exclusivement composée par de harengs maigres, caractérisés par de faibles concentrations de harengs guais.

6° Classes annuelles. — D'après la lecture des échelons, la concentration 1944—45 était composée de harengs de 2 à 14 ans avec une forte prédominance de la classe de 1936, hareng de 8 ans. (Pour plus amples détails concernant la composition au point de vue des âges, de la concentration 1944—45, voir tableau IV et 4e échelon de l'escalier biologique du hareng guai).

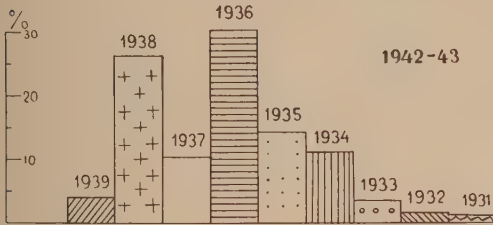
Tableau IV.

Fréquence des classes d'âges dans la concentration 1944—1945.

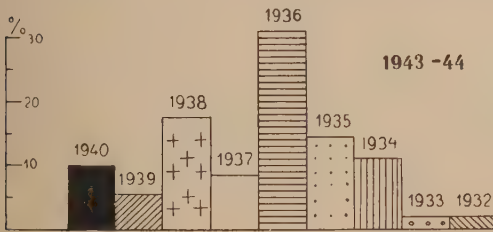
Nombre d'anneaux d'hiver	Age (ans)	Année de naissance	Nombre d'indiv.	Pourcentage
1	2	1942	1	0.2
2	3	1941	54	9.8
3	4	1940	58	10.5
4	5	1939	9	1.6
5	6	1938	106	19.3
6	7	1937	42	7.6
7	8	1936	168	30.5
8	9	1935	64	11.6
9	10	1934	35	6.4
10+	11+		11	2.0



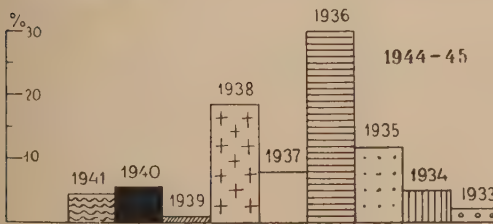
1941—42
Nombre de pêches..... 2,383
Apport kg. 10,006,971
Kg. par H. P. 125



1942—43
Nombre de pêches..... 9,165
Apport kg. 51,894,746
Kg. par H. P. 160



1943—44
Nombre de pêches..... 9,379
Apport kg. 58,119,500
Kg. par H. P. 130



1944—45
Nombre de pêches..... 3,889
Apport kg. 31,846,602
Kg. par H. P. 160

Age-Group III IV V VI VII VIII IX X XI

Fig. 1. Escalier biologique du hareng guai.

Tableau V.

Influence du nombre de vertèbres de la concentration 1944—45.

	Nombre d'individus	Catégorie numérique				Moyenne vert.
		55	56	57	58	
Nombre	150	12	66	68	4	56.43
er	250	9	94	131	16	56.62
er	150	4	58	78	10	56.63
	550	25	218	277	30	56.57
centage		4.54	39.64	50.37	5.45	

Tableau VI.

Pourcentage de chaque catégorie numérique de vertèbres, des quatre dernières concentrations de harengs guais: 1941—42 à 1944—45.

	Concen- trations	Nombre d'indiv.	Catégorie numérique					Moyenne vert.
			55	56	57	58	59	
	1941—42	225	7.1	40.0	44.0	8.4	0.4	56.55
	1942—43	525	2.1	44.8	47.8	5.3		56.60
	1943—44	700	4.1	46.2	44.4	5.3		56.51
	1944—45	550	4.5	39.6	50.4	5.5		56.57

7° Nombre de vertèbres. — La moyenne vertébrale de la concentration 1944—45 atteint 56·57, soit légèrement polyspondylique. En décembre elle était légèrement oligospondylique avec 56·43 comme moyenne vertébrale, tandis qu'en janvier et février elle était légèrement polyspondylique avec respectivement 56·62 et 56·63 comme moyenne vertébrale.

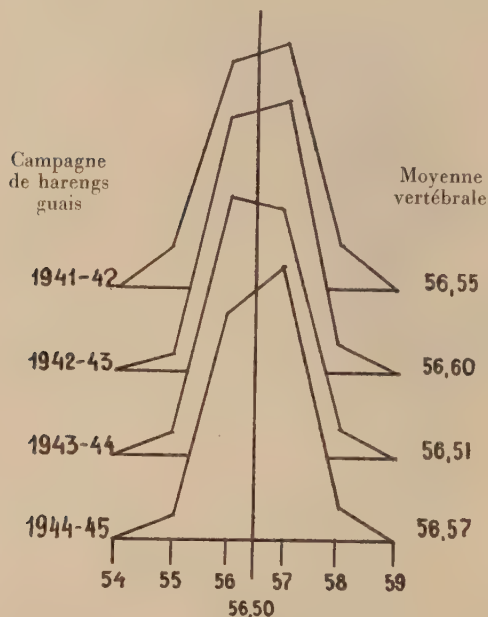


Fig. 2. Polygones de variations du nombre de vertèbres des harengs guais (1941—42 à 1944—45).

8° Contenu stomacal. — A part quelques estomacs qui contenaient quelques débris de copepodes (*Temora longicornis*) tous étaient vides.

C. Remarques et Conclusions.

L'étude de la moyenne vertébrale des harengs guais de la concentration 1944—45, montre une faible pénétration des harengs du type Manche dans la Mer du Nord à partir du mois de janvier.

Quant à la composition des classes de recrutement le jeune hareng de 3, 4 et 5 ans y reste

médiocrement représenté avec 22·1 %. Normalement leurs effectifs devraient atteindre plus 50 %. Aussi cette constatation est de mauvais augure pour la prochaine campagne, à moins que la "coming class" de 1942 y remédie en fournissant un riche contingent de harengs de 3 ans.

Comme prévu, la vieille classe de 1936, harengs de 8 ans, dominait encore de loin tout le reste (30·1 %).

La classe de 1938, harengs de 6 ans, y est avec 19·4 % normalement représentées.

Quant, à l'effectif fourni par la classe de 1936, harengs de 9 ans, il peut être considéré comme extrêmement satisfaisant, eu égard au grand âge de cette classe.

La prochaine concentration de 1945—46, se caractérisera probablement encore une fois par l'abondance de la classe de 1936, harengs qui auront l'hiver prochain 9 ans révolus, ce qui constitue un fait unique dans les annales de nos concentrations de harengs guais.

La classe de 1938, dont les individus auront atteint 7 ans, y fournira un contingent satisfaisant.

La jeune classe de 1941 est susceptible d'augmenter considérablement sa représentation dans les concentrations futures.

Les classes de 1939 et de 1937 restent marginales et continueront à jouer un rôle effacé dans l'avenir.

La classe de 1935, malgré son grand âge, n'est pas encore tout à fait épuisée, tandis que celle de 1934 disparaîtra dans les prochaines concentrations.

Les prévisions doivent également tenir compte d'une reprise certaine de la grande pêche d'automne aux harengs bouvards, jusque sur les côtes, situées dans le sud de la Mer du Nord et dans la Manche Orientale. Cette reprise constituera inévitablement un prélèvement considérable sur les stocks de harengs guais de l'hiver prochain et elle ne manquera pas d'exercer une influence néfaste sur le rendement de la pêche aux harengs guais.

Si les conditions atmosphériques et hydrographiques ne viennent pas contrarier nos pronostics nous prévoyons néanmoins une riche concentration moins riche toutefois que la précédente.

La qualité de la pêche sera également inférieure à la précédente: taille moyenne et poids moyen de l'espèce étant en baisse.

The East Anglian Herring Fishery in 1945.

By

William C. Hodgson.

THE first East Anglian herring season since 1939 began on October 8th 1945 when two drifters landed a catch of $6\frac{1}{4}$ crans of fish. It is inevitable that many difficulties would have been encountered, and it was equally certain that they would have to be overcome if the season was to be a success.

First of all, an area of the southern North Sea had to be cleared — as thoroughly as possible — of mines, and then, since the western boundary of the permitted area was about 16 miles from the coast, buoys had to be laid for the safety and guidance of the skippers. In addition, all the drifters going to use the area had to be "processed" in order to immunise them from the dangers of magnetic mines.

The season, if late in starting, continued into November and the following table shows the quantities of herrings landed at Lowestoft and Yarmouth.

	No. of Landings	Crans	Average catch per landing
Lowestoft	999	64,739	64.8
Yarmouth	1589	93,257	58.7

In 1938, there were more than 13,000 landings from the two ports and the average catch for each landing was 45 crans, which was then considered a high figure. In 1945, in order to limit the quantity of herrings landed to an amount which would not over-burden the port facilities, only 7 crans per man were allowed to be used in each landing. This meant that 63—70 nets were used, compared with about 90 nets per boat in 1938.

Thus we have a good indication that a very considerable increase in the size of the herring stock had taken place during the war years, for in spite of a reduction in the catching power of each vessel, the average landing figure showed a marked increase.

It was very unfortunate that it was not possible to carry out a full statistical and biological examination of the shoals at such an important time as this, for it would have been of great value to have had a complete survey of the fishery in the manner described in Rapp. et Proc.-Verb. Vol. CX, 1939.

When the season began, the Fisheries Laboratory was being re-established and I was still employed elsewhere, so it was very obvious that the most that could be done was to make a general qualitative examination of the shoals, so, at the beginning of November a start was made by measuring herrings on the market and taking a series of scale samples. These samples were taken by inexperienced assistants who had only been given a very brief course of instruction and it was afterwards found that many of the scales were unreadable, so, in consequence of this, too much reliance should not be placed on the results of the age-determinations. The ages of individual fish are probably fairly accurate, but, since many of the unreadable scales came from the larger fish, the proportion in which the age-groups appear may be a little faulty.

It is confidently expected, however, that by the time the 1946 season begins, we shall be in a position to undertake the work of finding out the actual increase in the size of the herring stock during the war years.

The general results of the market measurements and the age analysis of these fish are shown in Figures I and II, but, for reasons of economy, the tables on which the figures are based have been omitted.

If these figures are compared with the landings for the season of 1937 as shown in Rapp. et Proc. Verb. Vol. CX, 1939, it will be seen that

and 5 year-old fish are higher than those of similar fish in 1938. This is undoubtedly due to fact that in 1945 there were no data collected October when the younger fish appear in large numbers, and the average length as shown will therefore be a little too high owing to effects of shoaling. The weight/length ratio shows no measurable difference.

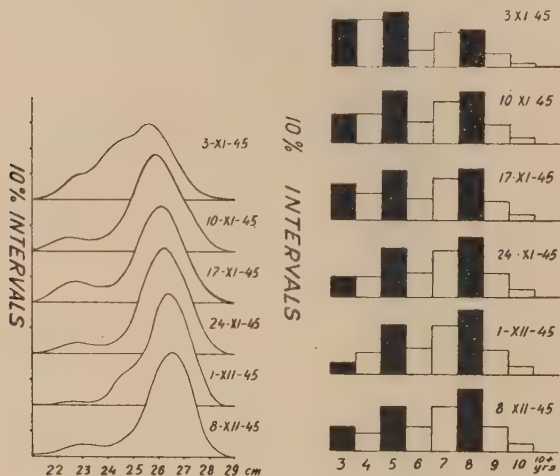


Figure I.

Figure II.

Length and Age of East Anglian Herrings in 1945.

there is a great similarity between the two seasons. The main age-groups were those of 5 and 8, and the new recruits — the 3 year-old fish — were present in considerable numbers throughout the whole season, which is somewhat exceptional. The length of the fish in 1945 is also similar to that observed in 1937.

In Table 1 the length and weight of herrings of each age-group for the seasons 1938 and 1945 are compared.

It will be seen that there is very little difference between the average lengths of the age-groups 6 to 9. In 1945 the average lengths of the 3, 4,

Table 1.

1938			
Age	Av. L (cm.)	Av. Wt (g.)	100 W L ³
3	23.1	105	0.852
4	24.2	120	0.847
5	25.7	141	0.831
6	26.2	153	0.851
7	26.4	152	0.826
8	26.8	160	0.831
9	26.9	165	0.848

1945			
Age	Av. L (cm.)	Av. Wt (g.)	100 W L ³
3	23.3	112	0.885
4	25.6	141	0.840
5	26.2	150	0.834
6	26.6	157	0.834
7	26.3	153	0.841
8	26.6	159	0.845
9	26.7	165	0.867

It appears from this cursory examination of the first post-war East Anglian fishery that the fish have not undergone any change during the period of hostilities, but there is evidence of an enormous increase in the stock. Contrary to what one might have expected, there is no evidence that, owing to the protection afforded by the period of the war, these herrings have grown to a greater size than in previous years. The proportion of fish of greater age than 10 years is negligible compared with pre-war years, and this suggests that these fish in the southern North Sea have an allotted span of life which is not lengthened by a six-year war.

Transition Area.

INTRODUCTION.

The following contributions have been received:

Hydrography.

Observations. By Helge Thomsen and J. C. Jensen, (p. 83).

Hydrographical Conditions off the Bohuslän coast during the years 1939—43. By A. R. Molander, (p. 87).

Observations made at the Flødevig Sea-Fish Hatchery, Arendal, Norway. By Alf Dannevig, (p. 11).

Benthonic Food.

Benthonic Food in the Limfjord. By Erik M. Poulsen, (p. 90).

Fish.

Danish waters: Plaice and herring. By Aage Jensen, (pp. 91 and 95).

Plaice, dab, eel, waste-fish, deep sea prawn and Norwegian lobster. By Erik M. Poulsen, (pp. 91, 92, 94, and 98).

Observations made at the Flødevig Sea-Fish Hatchery, Arendal, Norway (cod fish, lobster and oyster). By Alf Dannevig, (p. 102).

Haddock Fishery off the West Coast of Sweden, during the years 1939 and 1940—44. By A. R. Molander, (p. 106).

Stocks of Herring in the Skagerak and the Kattegat during 1941—45. By K. A. Andersson, (p. 110).

Growth of the Sprat at the West Coast of Sweden during the Cold Winters 1940—42 and some observations on the Great Coastal Fishery for Sprat during the years January—March 1943. By A. R. Molander, (p. 113).

Appendix.

Number of Vertebrates and Rays of the second year-class of Fishes from the Norwegian Skagerak. By Alf Dannevig, (p. 131).

The research work at sea has been much hampered in the Transition Area by the war and therefore, it has not been possible to give a general statement as to the hydrography and the condition of the stocks of food fishes.

Hydrography. The observations from the Danish waters, the Norwegian Skagerak coast and the Bohuslän coast all show that during the very cold winters 1940—42 not only the surface temperature of the water but also the temperature of the lower layers was considerably below the normal not alone in the winter but right into the summer season (July).

Benthonic Food. In the Limfjord it was observed that the stock of bottom invertebrates reached a minimum during the very cold winters, but increased in 1943—45.

Cod. Investigations with the Hensen net and ring-trawl in the Limfjord in the winter and early spring of 1945 showed that the spawning of cod in this water is quite insignificant. Norwegian (as well as Danish) investigations have shown that the 1938 year-class is a very strong one, and that small cod even during the summer of this year lived pelagically along the Norwegian coast feeding upon planktonic animals.

Haddock. A distinct increase of landings of haddock took place during the years 1943—44, this being explained by an improved stock of haddock (see p. 107). Especially notable was a remarkable increase in the number of large haddock during the two years.

Plaice. Danish investigations have shown that the year-classes 1940—42 were below normal as was to be expected from the low winter temperatures of these years. The year-classes 1943 and 45 were below normal too, but the 1944 class was above normal as was also the winter temperature of this year. The size and age of plaice in Danish commercial

catches were investigated. Everywhere the size increased until 1945; for the Kattegat this is no doubt due to the poor year-classes 1940—42. Transplantations of plaice were carried out from the waters round Thyborøn (North Sea) to the Belt Sea and adjacent waters in 1941 and 42 and to the central Limfjord in 1940—45. In connection with this marking experiments and age- and race-analyses were carried out.

Herring. Observations of age and racial characters of herring from various parts of the Danish waters are given; the 1937 year-class was rich, the 1938—42 year-classes were however poor (see p. 95).

Swedish investigations (see p. 110) have shown that the year-class 1937 of autumn spawners was abundant both in the Sound and in the Kattegat. On the whole during 1941—45 no rich year-class was produced in the Skagerak and the Kattegat. An interesting fact is that in 1944 the North Sea bank herring appeared in much larger quantities in the Skagerak than in the preceding years.

Sprat. It was observed (see p. 113) that the

growth-rate of sprat in the Swedish Skagerak fjord decreased during the very cold winters; in the winter 1943 when the temperature was normal the growth-rate again increased. These facts are partly from direct measurements and partly from the size of the growth-zones in the scales. However, the density of the year-classes influences the growth-rate of the rich year-classes having a lesser growth than the poor ones. A very good sprat fishery took place in the skerries along the Bohuslän coast in the winter of 1942/43. This is held to be due partly to a large stock caused by the slow growth during the cold winters in the Skagerak and partly to an immigration caused by an increased exchange of water in the fjords and a strong inflow of salt water.

Appendix. This deals with the number of vertebrae and rays of a series of year-classes of various species of fish and raises interesting questions about the variations in the number of vertebrae, which may vary not only from year-class to year-class but also within the same year-class from localities and locality, and from season to season evidently due to segregation according to temperature.

Erik M. Poulsen

ENVIRONMENT.

Hydrography of the Open Waters.

Table 1 and 2 the highest anomalies are in heavy type, the lowest in italics. The material consists of observations of salinity, temperature and of estimates of the direction and velocity of the surface current, carried out morning. More material is published in the *Danish Meteorological Annual*, issued by the Danish Meteorological Institute. The depth at the bottom at Anholt Knob is: 10 m, at Halskov Rev: 20 m.

Helge Thomsen.

The most outstanding feature of the hydrography of these years is the cold winters. On the general characters of these winters and their biological effects the following facts may be emphasized besides those mentioned below under the heading: B. The Fish.

The negative temperature anomalies at the surface after the cold winters prevailed in 1940 and 1941 until and including May, but in 1942 they were persistent until and including July. No doubt the low summer temperatures (caused partially at least by the cold winters) caused a low yield of the silver eel fishery, lowest in 1942. The temperatures shown in Fig. 7, p. 99 are calculated from observations at coastal stations, and we may assume that they differ to some extent from those in the open waters.

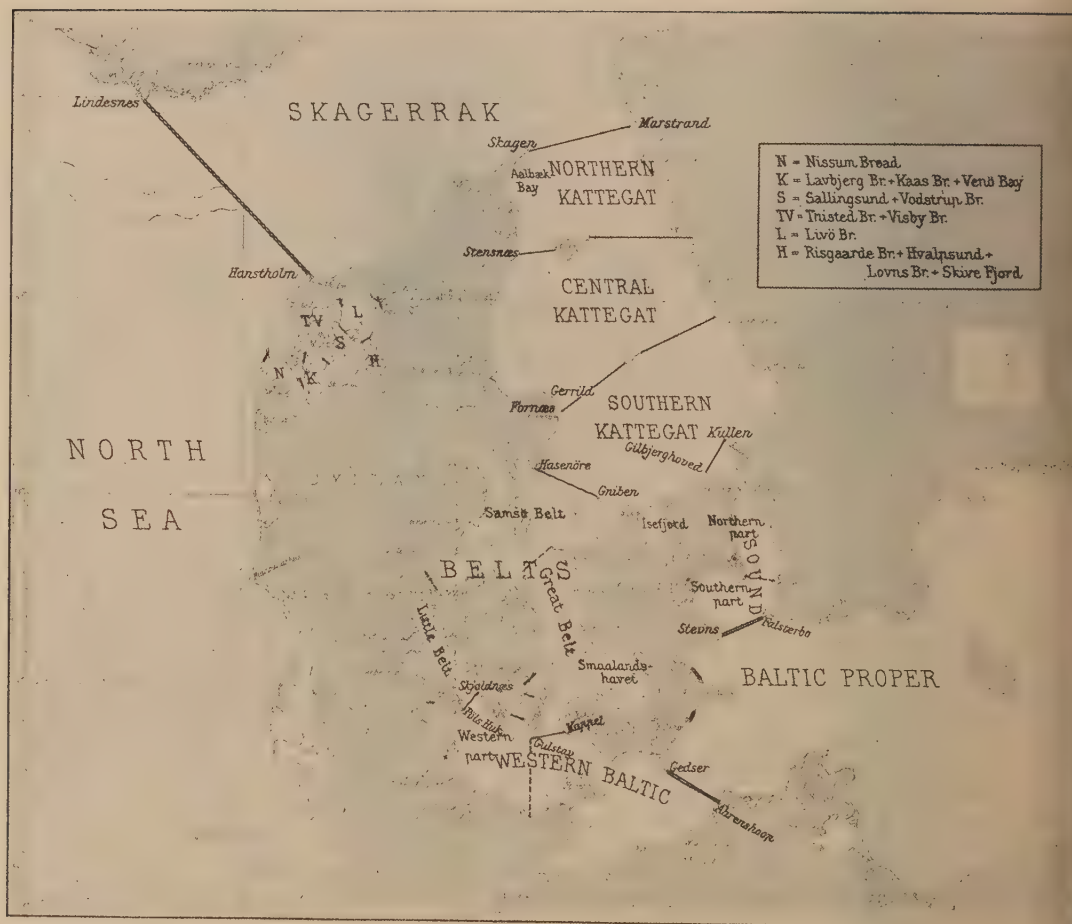
The bottom temperatures in the spring and summer are determined partially by the sur-

face temperature in the preceding winter, especially when this has been cold. Yet it is noteworthy that the negative anomalies at the bottom were much lower and more persistent in 1940 than in the two ensuing years.

From previous investigations one could expect that the low temperatures would call forth a poor year-class of cod and consequently a decrease in the yield of the cod fishery some four years later on. Owing to the war conditions we have no exact information as to the strength of the year-classes of cod during these years, but we may notice the fact that the yield of the cod fishery decreased substantially in the autumn of 1944. Comparing the fluctuations of the surface salinity at Halskov Rev (Table 2) with those of the resulting current (Table 3) we may state that the correspondence between them is rather small.

For making a correct use of the hydrographical data in explaining the biological facts it is necessary to bear the following in mind: after strong outflow from the Baltic the resulting current may be ingoing for one month (or even two months) before the surface salinity rises above normal. Consequently, the resulting current does not always give correct information as to the water masses which are transported through the Belt. The salinity (due regard taken to the other factors influencing it) may give the best information as to the transport.

Aage J. C. Jensen.



Map of the Danish Waters showing Limits between the Different Areas.

Table 2. Monthly Mean of Temperature at Surface and Bottom at the Lightvessels "Anholt Knob" (A) and "Halskov Rev" (H), respectively and Anomalies from this Mean.

(From the Danish Meteorological Institute, Nautical Dept.).

	X	XI	XII		I	II	III	IV	V	VI	VII	VIII	
Surface													
A Mean	10.9	7.1	4.1		2.2	1.4	1.9	4.5	9.4	14.2	16.8	16.7	14
H "	11.1	7.3	4.0		2.4	2.0	2.4	4.5	8.9	12.7	15.7	16.4	14
A 1939	-0.9	0.1	0.2	1940	Ice	Ice	Ice	-2.0	-0.4	1.9	1.2	0.0	-1
H "	-0.5	-0.1	0.1		"	"	"	-1.3	-0.6	2.8	1.9	-0.4	-1
A 1940	-0.9	0.1	-0.1	1941	Ice	Ice	Ice	-1.4	-1.5	-0.2	1.9	0.5	-1
H "	-1.1	-0.2	-0.2		"	"	"	-1.5	-1.8	0.9	2.4	0.2	-1
A 1941	0.4	-1.7	-1.4	1942	Ice	Ice	Ice	—	-0.7	-1.4	-1.2	0.2	-1
H "	0.1	-2.2	-0.1		"	"	"	—	-0.8	0.2	-0.4	0.6	-1
A 1942	0.9	1.1	1.2	1943	-0.5	1.3	1.8	1.6	1.3	0.9	0.6	0.2	-1
H "	0.8	1.2	0.6	"	-1.2	1.0	1.2	1.8	1.7	1.9	1.4	0.6	-1
A 1943	0.9	1.2	1.0	1944	2.2	1.3	-0.1	0.0	-0.8	-1.1	1.1	2.4	-1
H "	0.7	1.0	0.8	"	1.7	0.8	-0.1	0.2	-0.4	0.1	1.2	2.3	-1
A 1944	(1.4)	(0.3)	0.8	1945	-0.3	-0.5	1.3	(1.6)	—	—	—	—	-1
H "	—	0.3	0.4	"	(-0.6)	-1.3	0.8	—	—	—	(1.5)	1.1	-1
Bottom													
A Mean	12.1	10.2	8.1		6.1	4.7	4.3	4.3	4.9	6.7	9.7	12.7	13
H "	11.6	8.4	5.9		3.9	3.4	3.4	4.3	5.7	7.1	9.1	11.7	13
A 1939	-0.7	-1.6	-1.6	1940	—	—	—	-1.9	-2.7	-2.8	-1.5	0.7	-1
H "	0.9	0.3	-1.1	"	—	—	—	-0.9	-1.3	-2.6	-3.5	-0.8	-1
A 1940	-0.3	-0.9	-0.1	1941	—	—	—	0.6	-0.6	—	-0.8	1.3	-1
H "	-0.2	0.6	-1.2	"	—	—	—	-1.0	-0.2	-0.5	-0.6	-0.1	-1
A 1941	-0.6	-1.5	-2.0	1942	—	—	—	—	-0.7	-1.8	-0.6	-0.3	-1
H "	0.7	-2.4	-0.3	"	(-2.2)	—	—	—	-0.6	-0.4	0.3	-1.5	-1
A 1942	1.0	1.5	0.7	1943	0.7	-0.4	-0.1	1.0	1.1	1.1	1.1	0.3	-1
H "	0.4	0.8	-0.3	"	-0.4	0.4	0.4	1.2	2.6	0.8	-0.4	-0.5	-1
A 1943	1.8	2.1	2.3	1944	0.4	0.4	1.2	1.2	0.4	0.2	-0.7	-2.0	-1
H "	1.0	2.9	1.1	"	0.6	-0.3	-0.6	-0.2	1.3	-0.3	-1.5	-1.9	-1
A 1944	(1.2)	-0.6	-0.1	1945	0.9	0.6	0.1	(-0.3)	—	—	—	—	-1
H "	—	0.4	1.7	"	-1.4	-1.1	0.1	—	—	—	0.1	2.6	-1

In brackets: Material incomplete.

Table 3. Monthly Means of resulting Surface Currents in cm./sec. at the Lightvessel "Halskov Rev". The Current from the Baltic is stated as positive, towards the Firth as negative.

(From the Danish Meteorological Institute, Nautical Dept.).

	X	XI	XII		I	II	III	IV	V	VI	VII	VIII	IX
1939	-3.0	-22.0	-2.9	1940	(6.2)	—	—	(37.6)	-3.0	-7.8	-15.6	-6.7	5.1
1940	34.3	-23.7	2.4	1941	(12.4)	—	—	22.3	0.2	-26.7	17.5	-15.6	5.1
1941	-21.6	19.4	-38.5	1942	(49.1)	—	—	(40.8)	5.8	-13.0	8.0	33.9	5.1
1942	-5.7	-11.3	28.2	1943	7.1	-20.4	30.8	-13.1	24.4	-0.1	15.3	-3.3	5.1
1943	26.6	-1.1	2.3	1944	-15.1	52.3	-1.3	-2.2	16.3	26.6	9.6	-4.5	5.1
1944	—	-13.8	6.8	1945	22.9	-12.0	2.8	(12.1)	—	—	(12.7)	8.7	0.9

In brackets: Material incomplete.

Hydrographical Conditions off the Bohuslän Coast during the Years 1939—43.

order to explain the hydrographical conditions during the years 1940—42 and those directly preceding and following I have given graphical representations (Figs. 1 to 4) of the monthly mean temperatures (a) — Figs. 1 and 2 — of the water at 0, 10, and 20 m. depth, at Bornö station, in the in- part of the Gullmar Fjord, during the years 1939—43, and further (b) — Figs. 3 and 4 — of water at 0, 10, and 20 m. depth at Kolje Fjord during the months April to July, 1939—43. Temperature figures from Bornö result from observations throughout the year while the observations at Kolje Fjord were generally taken a week only during the months May (April) y. From Fig. 1 it will be seen that, from January to April, the surface temperature is much lower in 1942 than in 1939 and 1943. In May, the

differences are smaller, the radiation of the sun upon the sea surface having already had a considerable influence (see also Tab. 1). February 1940 shows the lowest mean temperature observed during these months.

Table 1.

Monthly Temperature Means, Surface Water, Bornö, Gullmar Fjord.

Year	Jan.	Febr.	March	April	May	Mean Jan.—May
1939	0.7	1.7	2.9	5.8	10.6	4.34
1940	0.3	—1.5	—0.2	2.0	10.3	2.18
1941	—0.9	—0.5	—0.2	0.9	9.0	1.66
1942	0.4	—0.8	—0.4	1.2	9.2	1.60
1943	0.5	1.6	3.3	6.1	11.7	4.64

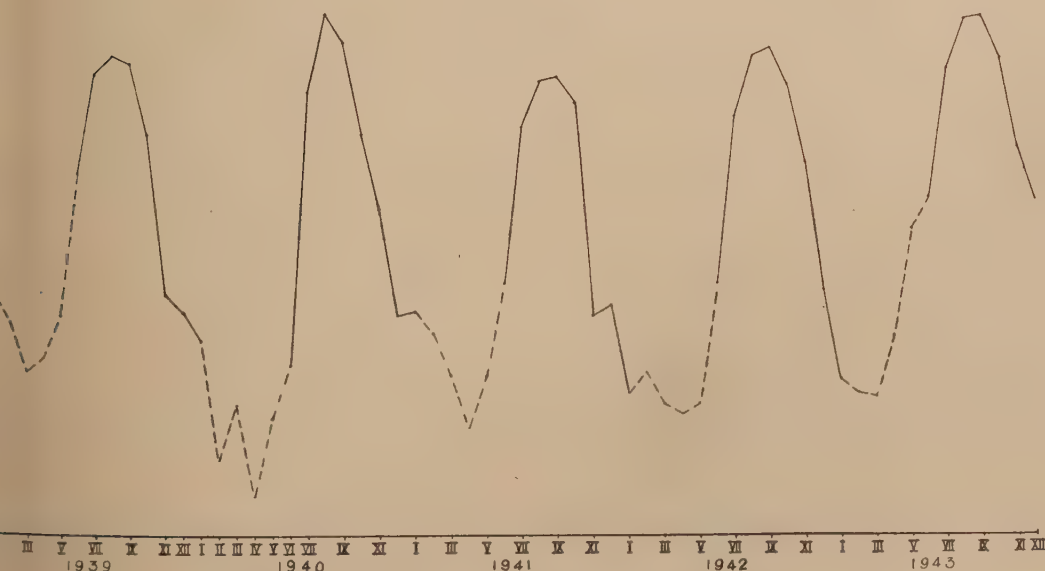


Fig. 1. The monthly Temperature Means of Surface Water at Bornö, Gullmar Fjord, during 1939—1943.

Table 2.
Monthly Temperature Means, 20 m. Depth, Bornö,
Gullmar-Fjord.

Year	Jan.	Febr.	March	April	May	June	Mean Jan.—June
1939	6.8	6.0	4.6	5.0	6.2	10.2	6.48
1940	5.5	2.1	3.7	1.1	3.3	4.8	3.41
1941	6.3	5.7	4.5	3.0	4.5	7.1	5.18
1942	4.0	4.6	3.7	3.4	3.7	7.1	4.41
1943	4.3	4.0	3.9	5.6	8.6	9.5	5.98

Table 3.
Monthly Temperature Means, 0, 10, and 20 m. Depth, Kolje Fjord.

Year	April			May			June			July	
	0	10	20	0	10	20	0	10	20	0	10
1940	—	—	—	12.91	2.88	0.42	17.27	4.11	0.63	18.71	8.10
1941	—	—	—	9.20	3.86	2.61	16.39	10.26	2.76	19.90	16.05
1942	—	—	—	10.57	3.09	4.38	13.91	4.88	4.62	16.86	7.04
1943	6.79	6.34	5.72	11.64	10.38	6.02	15.89	14.55	7.40	19.34	16.93

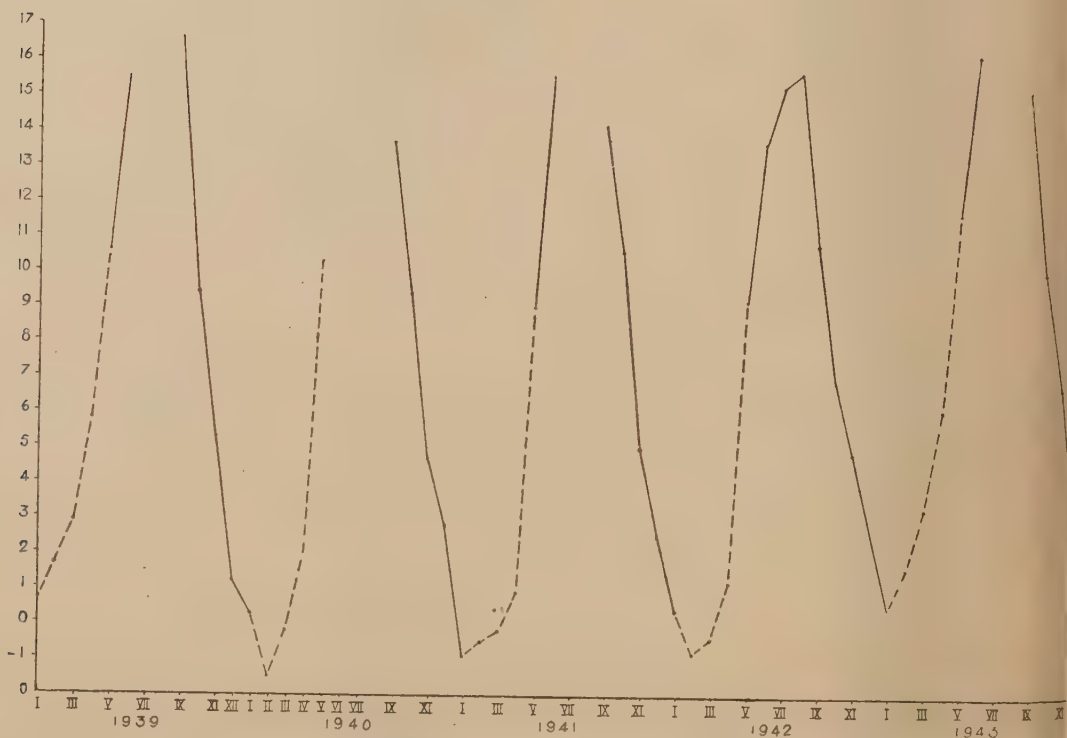


Fig. 2. The monthly Temperature Means at 20 m. Depth at
Bornö, Gullmar Fjord, during 1939—1943.

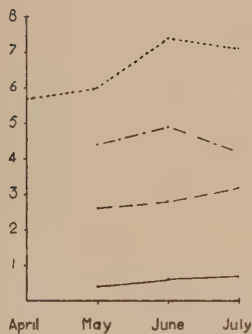


Fig. 4. Monthly Temperature Means at 20 m. Depth in the Kolje Fjord, April—July, 1940—1943.

1940 ——— 1941 ———
1942 —·—·— 1943 ·····



Fig. 3. Monthly Mean Temperatures at 10 m. Depth in the Kolje Fjord, April—July, 1940—43.

1940 ——— 1941 ———
1942 —·—·— 1943 ·····

At 20 m. depth (Fig. 2) even greater differences are found between the temperatures in January—June during the years immediately before and after the ice-winters on the one hand and those with ice-winters (1940—42) on the other. The low temperatures of spring and early summer in 1940—42 compared with those of the other years are most striking (Tab. 2). Also, at 20 m. depth, 1940 shows the lowest mean temperatures.

The results of the hydrographical observations at the inner part of the Kolje Fjord are given partly in Tab. 3 and partly in Figs. 3—4. From May to July, the surface temperatures are strongly influenced by the radiation of the sun, and the figures give therefore the temperatures at 10 and 20 m. depth. At this station also (Tab. 3) the differences between the mean temperatures of the ice-winters and of the year 1943 are very great. At 20 m. depth also exceptionally low mean values were observed in 1940.

Arvid R. Molander.

(A map of the area will be found on p. 114.)

Benthonic Food in the Limfjord.

Valuations of the sea bottom with the Petersen bottom sampler ($1/10 \text{ m}^2$) were carried out in the different broads and sounds of the western and central Limfjord in May—June as well as in September. The subjoined table gives the weight in grammes of bottom invertebrates per 1 m^2 . I=1st class plaice food (Polychaetes, Amphipods and all mussels excl. *Corbula*, *Nucula* and *Mytilus* and specimens of the other mussels larger than 3 cm.), II=*Mytilus* below size of 3 cm., III=2nd class food (*Corbula gibba* and *Nucula nitida*). Only the results of the valuations in the two larger broads, Nissum and Livø Broad, are recorded (A=Autumn valuations, S=Spring, and mean of these two):

Livø Broad				Nissum Broad			
	1st Class	Myt.	2nd Class	1st Class	Myt.	2nd Class	
A 1940	9.6	1.0	0.1	13.4	0	14.4	
S 1941	3.4	0	0.4	2.7	0	3.8	
Mean	6.5	0.5	0.3	8.1	0	9.1	
A 1941	11.2	0	2.2	4.4	0	20.2	
S 1942	6.0	1.9	1.5	1.3	0	11.3	
Mean	8.6	1.0	1.9	2.9	0	15.8	
A 1942	14.3	44.4	15.3	3.1	0	4.5	
S 1943	11.8	0	8.9	7.5	0	8.9	
Mean	13.1	22.2	12.1	5.3	0	6.7	
A 1943	28.5	19.0	23.0	23.2	0.3	22.7	
S 1944	9.7	1.5	11.5	13.8	0	4.1	
Mean	19.1	10.3	17.3	18.5	0.2	13.4	
A 1944	21.1	100.0	17.4	11.8	0	16.1	
S 1945	8.1	12.0	11.0	7.1	0	18.2	
Mean	14.6	56.0	14.2	9.5	0	16.2	

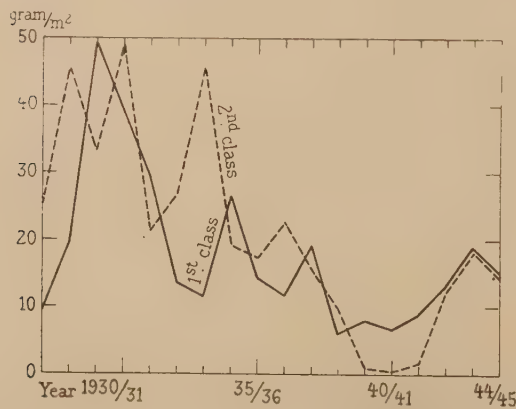


Fig. 1. Livø Broad.

It is of interest to note that the unusually heavy catches of *Mytilus* during the years 1940—1943, 6849 tons; 1941, 7365; 1942, 2296; 1943, 85,250 tons against the normal catch about 2000 tons) did in no way cause a diminishing stock of *Mytilus* brood. On the contrary the Livø Broad a rise in the number of *Mytilus* below 3 cm. occurred during the years 1940—

On a whole, however, the number and weight of the bottom invertebrates, which have been increasing since the years about 1932, still decreased in the years 1940—42 (see Figs. 1 and 2). In the Livø Broad (Fig. 1) the 1st class plaice food animals decreased from ca. 50 g./m² in 1929—30 to 8 g. only in 1938—42; in 1943—45 the weight has again increased a little. The same holds good for the 2nd class plaice food animals. In the Nissum Broad also the development has been the same, the number of bottom invertebrates reaching a minimum in 1939—42 and slightly increasing during the years 1943—45.

The fact that the fluctuations are the same in both 1st and 2nd class food animals makes it probable that the fluctuations are due not to variations in the stock of the fish feeding on the bottom invertebrates, but to variations in the conditions affecting the thriving of the invertebrates. Now during the period in question the natural conditions on two points have been subjected to sharp deviations from the normal. Firstly in 1932—33 the eel-grass (*Zostera marina*) disappeared almost completely from the Fjord¹). Secondly

¹) H. Blegvad: An Epidemic Disease of the Eel-grass (*Zostera marina*). Rep. Dan. Biol. Stat. XXXIX, 1935.

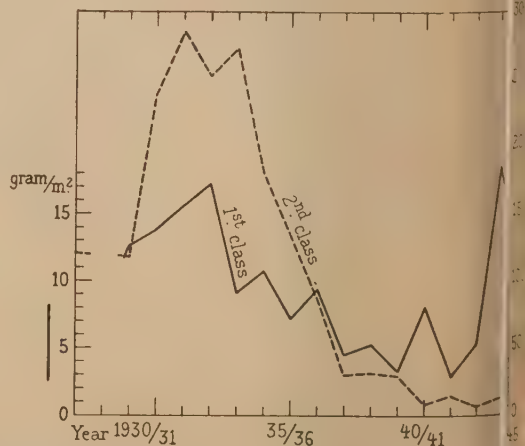


Fig. 2. Nissum Broad.

rs 1940—42 three severe winters followed
other. That the big decrease in the amount
om invertebrates has occurred simultaneous-
these two variations in natural conditions
dly be a mere coincidence. As the decrease
at the same time as the *Zostera*-disease and
ed for a series of years when the *Zostera*
ry scarce, it seems very probable that the
pearance of the *Zostera* has caused the de-
in the amount of bottom invertebrates. Al-
it is questionable if the bottom invertebrates
irectly on the *Zostera* and its decaying rem-
there can be no doubt that the large epi-

fauna and flora attached to the leaves (living or
dead) of the *Zostera* is of importance for the nou-
rishment of the invertebrates. The fact that a
smaller increase in the amount of bottom inverte-
brates has occurred in the last years (1943—45)
with mild winters indicates that the severe ice-win-
ters of 1940—42 have contributed to the decrease.
That the strong ice-winters have caused great da-
mage to the stock of bottom invertebrates is clear
alone from the fact that in springs after the ice-
winters large quantities of newly dead lamelli-
branches were taken in the bottom sampler.

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THE FISH.

Larvae.

the winter and early spring of 1945 hauls
made with the Hensen net and the 2 metres
rawl in the Limfjord in order to investigate
tent of the spawning of cod in that water.
ag from the occurrence of the growing-up cod
awning is considered to be small only¹).
the 19.—26. Jan. 1945 19 hauls were made
the Hensen net; these hauls only yielded a
of 8 cod eggs. From 17.—22. March 1945
auls were made with the Hensen net yielding
al of 17 cod eggs. In the same period 15
of 15 min. were made with the ring-trawl,
d larvae were caught. According to this the
ing of the cod in the Limfjord was of very
importance only. Larvae of other fish were
in numbers, of the sea-scorpion, for instance,
were thus up to 2224 larvae per 15 minutes.

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ce.

undance of Year-Classes determined y the Danish Quantitative Fishing periments with the Johansen Trawl.

is well known that meteorological-hydrogra-
al factors influence the strength of the year-
es. It is of special interest to note the influ-
of the temperature of the severe winters 1940,
and 42.

he strengths of the year-classes 1940, 41 and
ere below the normal in the central Kattegat,
Belts and the western Baltic as to be expected
the low temperatures of the winter months
p. 86). It is noteworthy that in the Skagerrak,

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Skr. udg. af Komm. f. Danmarks Fiskeri- og Havun-
gelser. Nr. 11. 1942.

Table 1.

Number of Plaice of the 0- and I-Group caught
per 30-min. Haul with Johansen-Trawl, compared
with the Average of the Years 1927—45.
(From the Danish Biological Station.)

	1940	1941	1942	1943	1944	1945	Mean of 1927—39
Skagerrak							
0	43	3	2	9	—	—	29
I	14	11	3	0.6	—	—	10
No. St.	13	12	8	13	0	0	
N. Kattegat							
0	69	21	11	15	—	—	47
I	3.1	60	22	12	—	—	26
No. St.	21	17	17	24	0	0	
C. Kattegat							
0	0.8	5	1	0.2	21	—	20
I	7	2	1	3	0	0	7
No. St.	25	19	15	11	17	0	
S. Kattegat							
0	55	10	0.5	5	12	12	13
I	1	0.5	0.1	0.0	0.0	3	0.9
No. St.	23	21	19	16	18	19	
Belts							
0	2	10	0.5	1.9	21	9	17
I	1.7	0.1	1.5	0.2	0.6	2.3	1.1
No. St.	60	105	81	114	134	123	
W. Baltic							
0	0.1	0.4	0.0	3	16	4	8
I	3	0.0	0.2	0.0	0.2	0.4	0.1
No. St.	17	9	11	9	10	12	
Sound							
0	16	9	0.0	0.6	8	7	12
I	0.0	0.2	8	0.0	0.3	0.0	1.5
No. St.	11	12	10	10	12	11	

At each station the numbers per 30-min. haul are cal-
culated. The means of these values are given for each
area.

As to the limits between the different areas see the
chart, p. 84.

¹) For the years 1928 and 1936—39 only.

Table 2. The Composition of the Stock of Plaice in the Nisum Broad.
Number of individuals caught per 30 min. with the eel-tog.

Age-Group	1937	1938	1939	1940	Year-Class 1941	1942	1943	1944	1945	Mean (1927—39)
Spring										
I	—	—	—	154.0	100.0	55.0	141.0	55.0	—	76.0
II	—	—	20.0	187.0	384.0	104.0	200.0	—	—	154.0
III	—	6.0	25.0	85.0	88.0	19.0	—	—	—	103.0
IV+	0.4	0.6	1.8	4.2	2.0	—	—	—	—	27.0
Autumn										
0	—	—	—	—	13.0	1.2	24.0	1.7	0.0	40.0
I	—	—	—	96.0	282.0	96.0	302.0	93.0	—	224.0
II	—	—	68.0	93.0	121.0	179.0	340.0	—	—	149.0
III	—	1.8	8.0	10.0	66.0	22.0	—	—	—	62.0
IV+	0.0	0.0	0.6	1.7	0.0	—	—	—	—	0.6

Fat types: above normal.

the northern and southern Kattegat and in the Sound the strength of the year-class 1940 was above the normal despite the fact that the cold during the first winter months of this year was just as severe as in 1941.

The year-class 1943 was poor and the year-class 1945 below the normal despite winter temperatures about and over the normal. The strength of the year-class 1944 was above the normal as to be expected from the high winter temperature of this year. It does not seem possible from the observations of currents, salinity etc. to explain why the strength of the other year-classes is not such as to be expected from the temperature.

Aage J. C. Jensen.

Abundance of Age-Groups of Plaice in the Limfjord.

(Data derived from experimental hauls.)

In the Limfjord no spawning of plaice takes place. The young plaice (0—II-Gr.) enter the fjord from the North Sea through the Thyborøn channel. The westernmost part of the fjord, the Nisum Broad, is the chief nursery ground, where the population is very dense and from where the plaice migrate eastwards towards the central part of the Limfjord. The density of the population decreases rapidly towards the east.

In Table 2 is shown the composition of the stock in the Nisum Broad as to year-classes and age-groups in the years 1941—45. It appears from the table that the year-classes 1940—41 and 1943 are above the normal, whereas 1939, 1942, 1944 and 1945 are below the normal.

Fig. 3 gives the variation in the number of plaice in the Nisum Broad and the Livø Broad for a longer series of years. The number has decreased rapidly since the years 1929—31. During the latest years 1942—45 the stock has improved a little again, being, however, still considerably smaller

than in the years 1929—31. From the curves in figure it appears that the stock in the inner part of the Fjord, f.i. the Livø Br. are subjected to the same fluctuations as the stock in the Nisum Broad.

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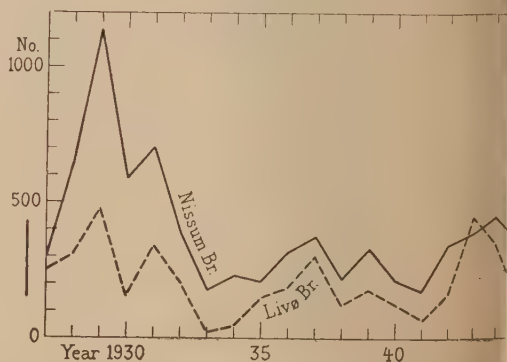


Fig. 3. Abundance of Plaice in Nisum and Livø Broad.

Danish Investigations on the Size and Age Composition of Commercial Catches of Plaice.

Representative samples taken at random from the landings have been measured. Some samples moreover have been age-determined. In the table below the length composition of samples taken from the Danish seine have been compared.

In the northern Kattegat most of the groups were closed for fishing from April 1940 on account of mines.

The accumulated stock of large plaice from the closed areas spread to the neighbouring areas.

Table 3. Length Composition (per mille), Northern Kattegat and Skagerak near the Scaw.
(The Danish Biological Station).

W. of Læsø, 6—11 m.			Off Sæby, 11—17 m.			Læsø Rende, 17—26 m.			N. of the Scaw, 40—70 m.	
1941	1943	1945	1941	1943	1945	1940	1943	1945	1943	1945
IV-V-VI	V	V	V	IV-V	VI	V	V	V-VI	VI-VII-VII	VII
5—10	8—11	8	11	12—15	14—17	17—26	20	20—21	40—65	40—70
4	2	1	1	3	2	2	1	2	3	1
56	65	20	59	24	42	11	—	—	—	—
915	874	959	871	405	800	712	234	862	527	161
29	60	20	71	404	116	256	681	138	328	629
—	—	—	—	150	42	14	64	—	127	210
—	—	—	—	17	—	7	21	—	17	—
1000	999	999	1001	1000	1000	1000	1000	1000	999	1000
27.2	27.9	27.8	27.9	32.1	28.8	29.6	33.3	28.8	31.2	33.6

Table 4. Length Composition (per mille), Central and Southern Kattegat.
(The Danish Biological Station).

N. of Djursland 11—14 m.			E. of Fornæs 17—19 m.			W. of Schultz's Grund 23—26 m.					
1940	1942	1945	1940	1941	1942	1945	1940	1941	1942	1943	1945
VIII	IX	VIII	VIII	VIII	VIII-IX	IX	X	IX	VII-VIII-IX	VII	VIII
11—14	14	10—12	19	18	17—18	18	24—28	22—26	20—26	26	23
4	1	2	1	2	2	1	4	2	4	2	1
—	—	—	—	—	—	—	—	—	—	—	—
969	—	826	694	194	26	152	660	402	284	310	—
30	556	169	194	663	601	674	308	311	395	363	654
1	444	5	14	142	311	174	32	233	307	300	186
—	—	—	97	—	62	—	—	55	14	26	160
1000	1000	1000	999	999	1000	1000	1000	1001	1000	999	1000
27.7	37.4	32.1	29.8	33.0	35.8	33.7	30.8	33.3	33.9	33.6	35.7

Table 5.
Length Composition (per mille) Aalbæk Bay,
November.

Year	1941	1945
Depth	7 m.	9—10 m.
No. of Samples	1	2
<25 cm.	0	5
26—30 cm.	881	449
31—35 cm.	119	282
36—40 cm.	0	259
41—45 cm.	0	5
Mean length	28.3	32.6

Table 6.
Age Composition (per cent) and Length of
Aalbæk Bay, November (see Table 5).

Year	1941			1945		
Age-Group	No.	%	cm.	No.	%	cm.
I	2	2	28.0	—	—	—
II	75	89	28.3	146	68	33.6
III	7	8	28.2	56	26	30.1
IV	—	—	—	14	6	31.6
Total	84	99	—	216	100	—

cially in 1943 the average length of the plaice
ht on most of the small areas open to fishing
very great.

The coastal waters of depths less than 10 m.
ed an exception from this rule. Here the fish-
was very intensive and — as normally — most
ne plaice here had been fished or had migrated

to deeper water before they had reached a length
of 30 cm.

Yet, in the late autumn months the stock in the
coastal waters of Aalbæk bay was markedly in-
fluenced by the accumulated stock from the closed
areas. During these months the Aalbæk bay is
visited by mature or maturing plaice on their

route from the Kattegat to the spawning places in the Skagerak (or the North Sea).

The length and age composition of catches (by nets) from the Aalbæk bay in November and the mean length of the age-groups are shown in Tables 5 and 6 respectively.

In the medium depths of 10–30 m. the average length of the plaice caught had decreased from 1943 to 1945, and here the mean length was in 1945 about the same as in 1940–41. It does not seem possible to explain this change from the changes in the strength of the year-classes and thus we may seek the cause partly in the intensive fishery on the very restricted areas which were free from mines, removing especially the fastest growing fish, partly also in a diminished growth-rate in the accumulated stock in the closed areas.

In the deeper waters to the north of the Scaw the length of the plaice caught seems to have increased down to 1945 (see Table 3).

In the central and southern Kattegat the average length of the plaice caught increased until 1945 (see Table 4). Except in the depth over 20 m. in the southernmost Kattegat the length had further augmented in 1945, in the other areas it had decreased somewhat in 1945 but still it was some cm. higher than in 1940. For all these areas the fluctuations may seem to be explained naturally by the fluctuations in the strengths of the year-classes. The rich year-classes 1938 and 1940 followed by the poor year-classes of 1941, 42 and 43 must have affected a commercial stock showing a steady increased mean length down to 1944 when the comparatively many plaice from the normal or good year-class 1944 in 1945 must have begun to mark their existence in the lesser depths by a decrease in the mean lengths of the plaice caught. In the greater depths which the plaice of this year-class had not reached in 1945, the mean length of the commercial plaice must still have increased.

Aage J. C. Jensen.

Transplantations of Plaice.

Owing to the war it has been possible to carry out only a minor part of the normal transplantations, viz.:—

- A. Transplantations to the Belt Sea and adjacent waters:
 1940. No transplantations.
 1941. 40,000 kg. from the coastal area of the North Sea off Thyborøn.
 1942. 44,000 kg. from the coastal area of the North Sea off Thyborøn.
 - 1943–45. No transplantations.
- B. Transplantations to the central part of the Limfjord.
 1940. 108,000 kg. from the Nissum Broad.

1941. 68,000 kg. from the coastal area of North Sea off Thyborøn.
1942. 84,000 kg. from the coastal area of North Sea off Thyborøn.
1943. 60,000 kg. from the coastal area Nissum Broad.
1944. 60,000 kg. from Nissum Broad.
1945. 52,500 kg. from Nissum Broad.

The size of the transplanted plaice varied so what from year to year:—

Year	kg./score	mean length, cm.	% of each age group		
			II	III	IV
1940	1.5	18.4	5	91	4
1941	1.8	19.5	3.6	86.3	6.7
1942	2.0	20.1	16.2	63.3	19.5
1943	2.5	23.0	3.5	77.1	18.9
1944	2.0	20.9	9.4	80.3	10.0
1945	1.8	18.6	31.7	49.7	18.7

In the years 1940–44 by far the largest part of the transplanted plaice was 3 years old (III-Gr.); in 1945, however, the 2-year-olds (II-Gr.) were fairly well represented. In the years with the mean length is comparatively low either II-Gr. is rather strong or the IV-Gr. rather poor. When the mean size is comparatively high (1945) the IV-Gr. is far more abundant than the II-Gr.

In connection with the transplantations marking experiments were carried out.

In the Belt Sea in 1941 800 fish were marked; during the first year 13 % were recaptured. This rather small percentage is no doubt due to the strictions in the fishery caused by the war. The growth of the plaice was good, in mean 10 % from April to December.

Also in 1942 800 plaice transplanted to the Belt Sea were marked. 23 % of these were captured until Jan. 1st 1943. The weather conditions during the transplantations were very good and even on the long voyages from Thyborøn to the Lille Bælt the mortality was very low, only 1½–1 %.

As in the previous year samples of marked plaice from the Belt Sea were analysed during the autumn. The percentage of transplanted fish in these samples was 18 against 6 % only in the previous year.

A not unimportant number of the plaice transplanted and marked in 1942 were recaptured through the year 1943, i.e., in the 2nd year after the transplantation: in 1942 23 % were recaptured and through 1943 no less than 9.5 %.

The markings of both years, as all the previous markings, have shown that only very few of the transplanted plaice emigrate back to the North Sea.

in the Limfjord the following markings have been carried out:

Year	No. marked	% recaptured within a year
1940	500	17 0/0
1941	500	19 0/0
1942	600	28 0/0
1943	500	6 0/0
1944	500	4 0/0
1945	250	13 0/0

the years 1943 and 44 the recaptures have been very few only; this undoubtedly is caused by restrictions in the fishery due to the war conditions. The growth of the marked plaice was good and emigrations out of the area were few; in some years none at all.

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in the Limfjord the dab does not spawn. It migrates (just as the plaice) to the fjord from the North Sea. The Nisum Broad is an important spawning ground, towards the east of the fjord the number of dab decreases rapidly. The dab is not common in the fjord as the plaice. The stock of dab in the fjord has — as was the case with the plaice stock too — decreased rapidly since 1931.

Table 7 gives a survey of the composition of the stock in the Nisum Broad as to year-classes and age-groups. The strongest year-class during the last years is the 1941 one, next come 1942 and 1940; 1939, 1943 and 1944 must be regarded as poor year-classes. It is of interest to note that the stock of dab — just as it is the case with the stock of plaice — is much more dense in the autumn than in the spring. This shows that

the immigration is especially strong during the summer months; other investigations have shown that this immigration mostly occurs during the early summer.

Erik M. Poulsen.

Herring.

Size and Age Composition of Danish Catches.

Samples from various herring fisheries have been investigated as to size, age, maturity, and race. Some of the results, showing the fluctuations in the stocks from year to year, are put down in the tables below. A few of the samples contained a number of herring less than 18 cm.; these small herrings have been omitted in this compilation.

The two races analysed in the Tables 8—13 are from about the same area; they have exactly the same total number of vertebrae, but their number of praehaemal vertebrae shows a significant difference.

From Tables 9 and 12 we note that the autumn herrings are generally a little older than the spring herrings. During the years concerned the fluctuations in the strength of the year-classes have been much more pronounced for the autumn herring than for the spring herring (cp. Figs. 4 and 5).

As for the autumn herring the year-class 1934 has been more or less above the normal (the 3-year-old herrings in 1937, the 4-year-olds in 1938 etc.). The year-class 1937 has been still better, yet it has not been very rich since by 1943 there were rather few of these herrings left. The yield of the autumn herring fishery was therefore rather poor.

A sample taken in pound nets during the season 1943 (29/9) was procured for examination. Almost all of these herrings were small and immature of 17—20 cm. lengths, and a racial analysis gave the V.S.=56.21 (124 sp.), V.P.=23.88, which in-

Table 7.
The Composition of the Stock of Dab in the Nisum Broad.
Number of individuals caught per 30 min. with the eel-tog.

Year	Spring.							Mean (1927—39)
	1937	1938	1939	1940	1941	1942	1943	
I	—	—	—	34.0	80.0	17.0	12.0	15.0
II	—	—	0.6	20.0	52.0	39.0	13.0	21.0
III	—	0.0	1.0	1.0	22.0	6.0	—	6.0
IV+	0.0	0.0	0.0	0.0	0.0	—	—	0.5
Year	Autumn.							Mean (1927—39)
	1937	1938	1939	1940	1941	1942	1943	
I	—	—	—	14.0	48.0	87.0	21.0	81.0
II	—	—	1.8	0.4	19.0	21.0	8.0	46.0
III	—	0.0	0.2	0.0	0.0	1.0	—	4.0
IV+	0.0	0.0	0.8	0.0	0.0	—	—	1.6

Fat types: above normal.

The Spring Herring N. of Seeland.

(see Tables 8—10).

Table 8.

Percentage Size Composition.

(Caught in pound nets near Hundested. Maturity II—VII, mostly IV—VII.)

Year Date	1941 30/4	1942 6/5	1943 17/5	1944 26/4
18 cm.	—	—	1	—
19 "	13	—	3	8
20 "	7	7	5	18
21 "	7	20	16	20
22 "	13	34	18	19
23 "	22	28	18	19
24 "	24	9	15	10
25 "	10	2	15	5
26 "	3	1	6	1
27 "	—	—	2	—
28 "	—	—	1	—
Total	99	101	100	100
Mean Length, cm.	23.3	22.7	22.4	22.3

Table 10.

Age-Groups, Average Length in cm.

(In brackets: Number of herrings investigated).

Year Date	1941 30/4	1942 6/5	1943 17/5	1944 26/4	Mean 1941—44
2 years	22.0 (35)	21.9 (62)	20.6 (38)	21.0 (96)	21.4
3 "	22.5 (88)	23.9 (166)	22.4 (96)	22.8 (94)	22.9
4 "	24.2 (85)	23.3 (36)	23.8 (39)	24.7 (29)	24.0
5 "	24.8 (14)	23.7 (3)	24.9 (9)	25.2 (6)	24.6

icates that they were local spring-spawning herrings. The succeeding year-classes 1938—42 must have been poor since the yield of the autumn herring fishery has totally failed in each of the years 1944 and 1945. It has not even been possible to procure samples for investigation, while the small catches were used by the fishermen themselves and their nearest friends.

During the years 1939—44 the races of herring in 14 catches from the waste-fish and the sprat-fishery in the central and southern Kattegat and the Belt Sea were investigated; one of them from 1939 contained autumn herring of the same type as the Odden—Djursland herring. They were of the rather good year-class 1937, in each of the other samples the total number of vertebrae in the autumn herrings was considerably higher than that of the Odden—Djursland herring (as well as of the other autumn herrings spawning in the Belt Sea). Some spring-spawning herrings of the year-classes 1938—44 of races belonging in these waters were found in these samples of small herrings. This result supports the supposition, that the year-classes 1938—42 have been really poor.

Table 9.

Percentage Age Composition and Racial Character

(No.: Number investigated as to race.)

Year Date	1941 30/4	1942 6/5	1943 17/5	1944 26/4	Mean 1941—44
2 years	15	23	20	42	25
3 "	37	62	51	42	48
4 "	36	14	21	13	21
5 "	6	1	5	3	4
6 "	4	—	2	—	2
7 "	1	—	—	—	—
	99	100	99	100	100
V. S.	55.94	55.92	55.80	55.97	55.91
V. P.	23.64	23.82	23.64	23.50	23.65
No.	158	120	92	110	

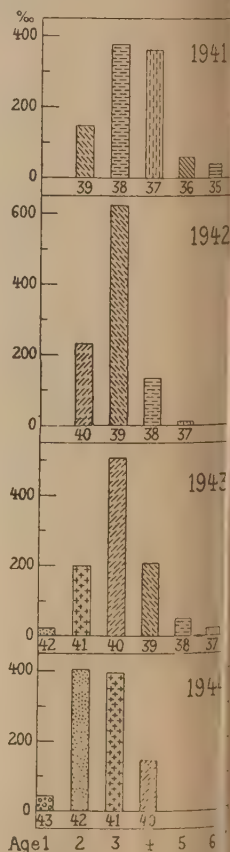


Fig. 4. Strength of the Year-Classes, Spring Herring, N. of Seeland.

No doubt the low temperatures of the winters 1939—40, 1940—41 and 1941—42 have contributed to the bad survival of the 1939—40 and brood, respectively.

The Odden—Djursland Autumn Herring.

(See Tables 11—13).

Table 11.

Percentage Size Composition.

(Caught in nets (N.) or pounds nets (P.))

Year	1937	1938	1939	1940	1941	1942	Mean
Date	13/9	26/10	25/10	20/10	2/10	21/9	1937—42
	N.	N.	N.	N.	P.	P.	
19 cm.	—	2	1	—	—	—	0.5
20 "	—	4	6	—	8	—	3.0
21 "	3	9	6	2	21	—	6.0
22 "	6	7	14	9	28	—	10.0
23 "	26	20	25	16	13	1	16.0
24 "	28	10	12	24	10	4	15.0
25 "	19	16	10	9	7	24	15.0
26 "	10	17	8	9	11	39	16.0
27 "	6	8	13	12	2	18	11.0
28 "	2	7	4	10	—	10	5.0
29 "	—	—	2	6	—	3	2.0
30 "	—	—	1	2	—	—	0.5
Total	100	100	102	99	100	99	100.0
Mean							
Length, cm.	24.7	24.6	24.5	25.6	23.2	26.6	24.9

Table 12.

Percentage Age Composition and Racial Characters.

(No.: Number of herrings investigated as to race.)

Year	1937	1938	1939	1940	1941	1942	Mean
Date	23/10	26/10	25/10	20/10	2/10	21/9	1937—42
2 years	4	6	7	—	1	—	2
3 "	72	41	36	32	33	1	36
4 "	19	31	24	21	54	12	28
5 "	3	16	19	21	11	72	24
6 "	1	5	9	16	1	10	7
7 "	—	1	3	4	—	4	2
8 "	—	—	1	3	—	1	1
9 "	—	—	—	1	—	—	—
10 "	—	—	1	1	—	—	—
	99	100	100	99	100	100	100
V. S.	55.95	55.85	56.00	56.10	55.82	55.79	55.92
V. P.	24.42	24.28	24.33	24.47	24.31	24.27	24.35
No.	116	82	123	119	100	119	

Table 13.

Age-Groups, Average Length in cm.

(In brackets: Number of herrings investigated).

Year	1937	1938	1939	1940	1941	1942	Mean
							1937—42
3 years	24.3(85)	23.4(34)	23.1(44)	23.5(38)	22.0(33)	26.1(16)	23.7
4 "	26.3(23)	25.3(25)	24.6(29)	24.7(25)	23.4(54)	26.5(100)	25.1
5 "	26.8(4)	27.4(13)	25.7(23)	26.4(25)	26.1(11)	27.0(14)	26.6
6 "	—	27.5(4)	27.4(11)	28.1(19)	—	28.5(6)	27.9

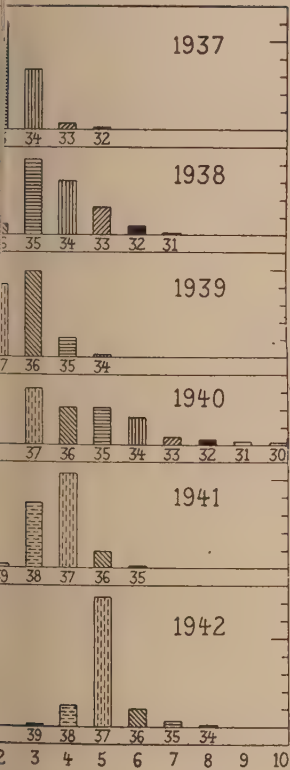


Fig. 5. Strength of the Year-classes, Odden—Djursland Autumn Herring. Pound Net Herring in 1937 and 1939, for the other years as in Table 12.

Quantity of Herring landed.

Table 14.
Yield of some of the Danish Herring Fisheries.
(In metric tons, boundary area between the Kattegat
and the Belts: Grenaa—Odden—Hundested.)

	Mostly Spring Herrings March—July	Mostly Autumn Herrings August—Dec.
1939	173	390
1940	580	1558
1941	523	785
1942	385	396
1943	339	174
1944	184	56
1945	106	76

The number of small herring can be estimated from the weight, using the average weight of these herrings stated by H. Blegvad in Beretn. fra den danske biologiske Station XLVIII, 1945. It was 14.8 and 16.5 g. per herring for the northern area (Skagerak and northern Kattegat) and the southern area, respectively. The number of small herrings caught in 1943 by the waste fishery in the northern area has been estimated by Blegvad to 218 millions caught by the offshore trawl fishery and 286 millions by shore seine.

Naturally the opinion has been set forth by the fishermen that the failure of the herring fishery in 1943, 1944 and 1945 was caused by the new fishery for waste fish. The small herring caught by the waste fishery were mostly 9—17 cm., i.e., mostly in their second year of life.

In the Skagerak and the northern Kattegat 14 samples of herrings from the waste fishery were investigated in 1939—44.

According to the racial analysis of these samples trawl-caught herrings of the Danish waste fishery in 1943 consisted more or less of the following numbers in the northern area:

	Millions
W. North Sea autumn herring	120
Kattegat "Vaar" herring ("winter herring")	50
Spring herrings from Kattegat—Skagerak	25
Thyborøn autumn herring	10
Kobbergrund herring	10

The number of autumn herrings belonging to the western North Sea race is insignificant as compared with the great number of grown-up fish caught (normally more or less 3000 millions a year). For the stocks of herring belonging to the Skagerak and Kattegat races the waste-fish fishery may reduce the number of herrings at disposal to the normal herring fisheries to a perceptible degree, although by a small fraction only.

In the southern Kattegat and the Belt Sea no herrings of the autumn-spawning races of these

waters were found in the waste-fish samples for 1939—44, except for some of the rather good year class 1937. It is evident then that we have reason to believe that the waste-fish fishery is cause of the failure of the autumn herring fishery in these waters. The cause must be sought for the bad survival of the brood in 1939—42.

Yet from the number of small herring caught by the waste-fish fishery in these waters we may suppose that this fishery can reduce the number of herring at the disposal of the normal herring fisheries here by some percent, and it is by no means to be excluded that an intensive fishery for waste fish in a rather closed area such as the western Baltic can ruin its normal herring fisheries (see also the present author in *Dansk Fiskeritidning* 23/2 1945).

Aage J. C. Jensen

Eel.

Quantitative Fishing Experiments.

In the Limfjord the number of eels has increased during the later years. In the years 1941—45 the following number were caught in the eel-tog per 30 minutes:

1941	1942	1943	1944	1945
1.0	0.8	0.6	0.5	1.0

The mean catch figure for the years 1937—40 is 1.9, it is twice as much as in the years 1941—45. This decrease (see Fig. 6) is no doubt partly due to the severe ice-winters 1940—42 causing undue damage not only to the stock in the fjord but also to the eels growing up in the adjacent fresh water and emigrating as silver eels through the fjord and partly to the increased fishery with otter trawls being allowed in the fjord since 1940.

Erik M. Poulsen

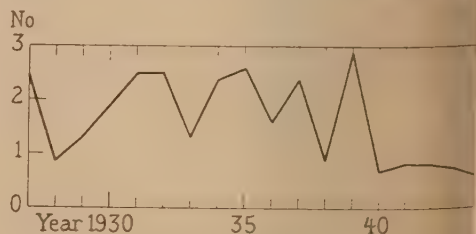


Fig. 6. Catch in Eel-Tog per 30 min.

The Commercial Fishery.

In Fig. 7 the weight-yield of the eel fishery with weels and pound nets has been compared with the surface temperature of the water. Since 19

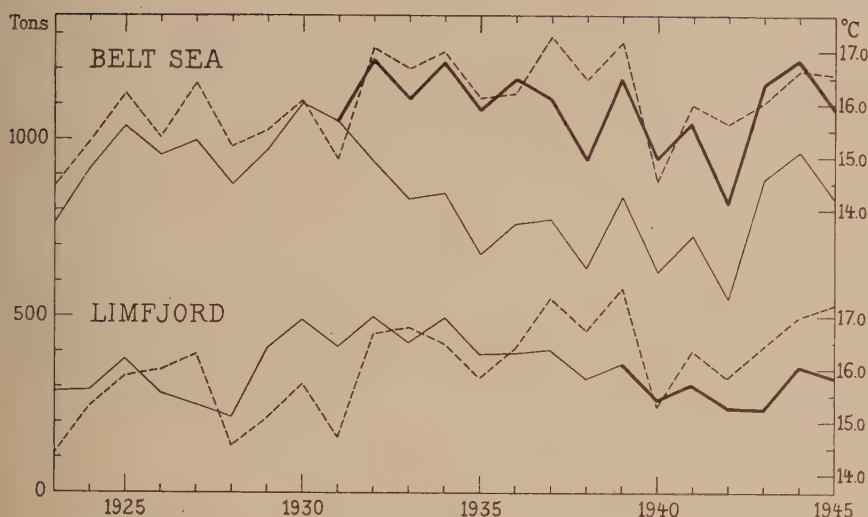


Fig. 7.

— Weight-Yield of the Catch of Silver Eels
 - - - Weight-Yield of the Catch of Silver Eels and of Yellow Eels from Weels.
 . . . Surface Temperature of the Water.

fishery for yellow eels has been carried out (summer, this fishery taking a rather great part of the eels which otherwise would have been taken as silver eels later on in the season. From the figure it is evident that the fluctuations in the catch of the eels correspond far better than those of the silver eels alone with the fluctuations in the surface temperature. No doubt a main cause of the fluctuations in the yield of the silver-eel fishery is also to be found in the disappearance of the eel grass (cp. present author in *Dansk Fiskeritidende* 1937,

in the figure it is evident also that the yield of the silver-eel fishery in the Limfjord during the years 1936 has shown a tendency to be rather much higher than that expected from the temperature. A main cause must be sought for in an increase in the yield of the silver-eel fishery carried out about 1935.

neither of the waters a special decrease in yield has been found in 1940-42 and, therefore, we may suppose that the effect of the cold years on the yield of the silver-eel fishery has been very great.

Aage J. C. Jensen.

Waste Fish.

During the last ten years and especially during the war years a considerable increase has taken place in the fishery for "waste-fish", i.e., fish used for pond fish or for the manufacture of various industrial products (fish meal and oil).

H. Blegvad: On the Waste Fish Fishery. Rep. Dan. Biol. Stat., XLVIII, 1946.

The catch of waste fish was as follows (in mill. kg.):—

1939	1940	1941	1942	1943	1944
11	7.5	11	18.6	23.7	16

There is no doubt that the sudden and great rise in the yield during these years was caused by the war conditions.

During these years numerous samples of waste fish have been examined by the Danish Biological Station¹). Young of such important food fishes as plaice, flounder and cod are not caught in any important number among the waste fish, and the waste fish mainly consists of whiting, small herring and small sprat. In areas where the herring fishery mainly depends on local races an intense fishery for waste fish will no doubt cause considerable damage to the herring fishery. Also the sprat fishery is threatened by this fishery.

In the years 1939-44 the following weight percentages of the various species were found in the samples investigated from the northern part of the Transition Area (Hirtshals-Skagen) and from the southern part (southern Kattegat and Belt Sea).

	Northern Part	Southern Part
Whiting	53	14
Herring	19	66
Sprat	10	12
Mackerel	6	3
Cod, haddock, plaice	2	0.5
Other Fish and invertebrates	10	4.5

Erik M. Poulsen.

Deep Sea Prawn and Norwegian Lobster.

Since 1931 a fishery for these two crustaceans has been carried out in the Skagerak and for the Norwegian Lobster in the Kattegat¹⁾ also. In the years 1940—44 the catch in tons was as follows:

	Deep Sea Prawn	Norwegian Lobster
1940	218	62
1941	293	49
1942	393	106
1943	590	300
1944	274	438

¹⁾ Erik M. Poulsen: Investigations on the Danish Fishery for and Biology of the Norway Lobster and the Deep-Sea Prawn. Rep. Dan. Biol. Stat., XLVIII, 1946.

Since 1931 the deep sea prawn fishery has been steadily rising, only in 1944 was there a rather sharp decrease. The yield of the fishery for Norwegian Lobster rose steadily from 10 tons in 1931 to 800 tons in 1939. During the years 1940—42 a big decrease occurred, due no doubt partly to restrictions in the fishery by the war, and partly to the severe ice-winters of 1940—42 causing damage to the stock.

These two crustaceans are also fished by Norwegian and Swedish fishermen. As the area of distribution, and consequently the stock too, is rather limited, it is feared that the intense fishing can have a detrimental effect upon the stocks, and therefore international measures for the protection of the stock should be introduced.

Erik M. Poulsen

Extracts of Observations made at the Flødevig Sea-Fish Hatchery, Arendal, Norway.

By
Alf Dannevig.

Hydrography.

At the Flødevig Sea-fish Hatchery the temperature and the specific gravity of the sea water are recorded every working day. The observations taken below the surface have the greatest influence on the values at the surface are influenced by the fresh water discharged in the neighbourhood of heavy rainfalls, and during winter the ice and the wind are a hindrance for measuring the temperature of the sea water.

During the hatching seasons February—March and July—August, the temperature and the specific gravity is also measured daily in the pump-coming from approximately 15 metres.

Fig. 1 gives the average temperature and salinity for the years 1919—45 for 1 metre. It also shows the anomalies from that average for the 10 years.

It is worth mentioning the cold winters 1940

The negative anomalies are very high and in some months, e.g., February 1941, the actual average temperature is 0.60° below zero, in March it is 0.10° below zero. At the same time the salinities were extraordinarily low. The average for February 1941 was 14.3, for February March 1942 it was 2.3 and 5.9 ‰. It is probable that this is responsible for the low salinities. The fresh water coming out from the rivers accumulates under the ice. There are no waves and the currents are slowed down under these circumstances.

Some observations taken from the ice near the wharf of Torungen on February 6th 1942 may give an illustration as to the upper layers.

We have a negative temperature down to 30 metres, the lowest —1.5° at 10 metres. The very low temperatures are found in water with a sal-

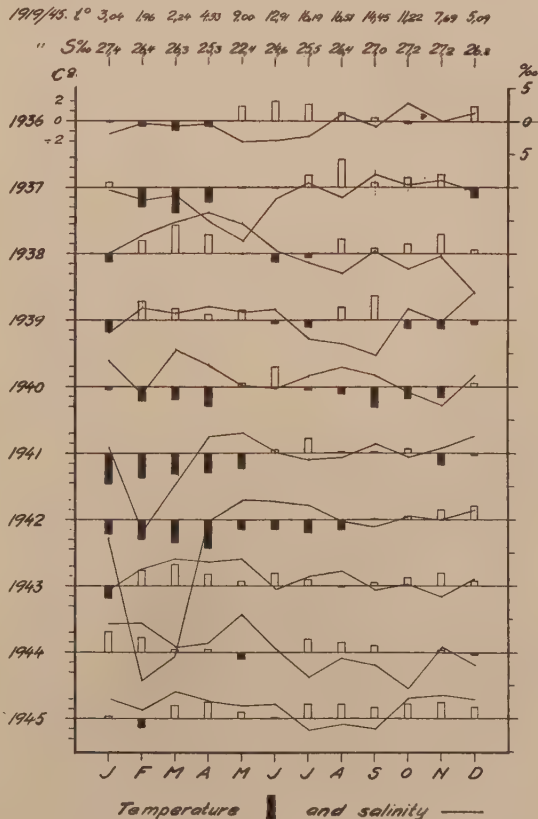


Fig. 1. Deviation from Mean at 1 metre at Flødevigen.

0	1	2	10	20	30	40
3.7	10.5	27.9	29.0	29.0	29.3	30.5
-0.1	-0.6	-1.4	-1.5	-1.4	-1.0	0.6

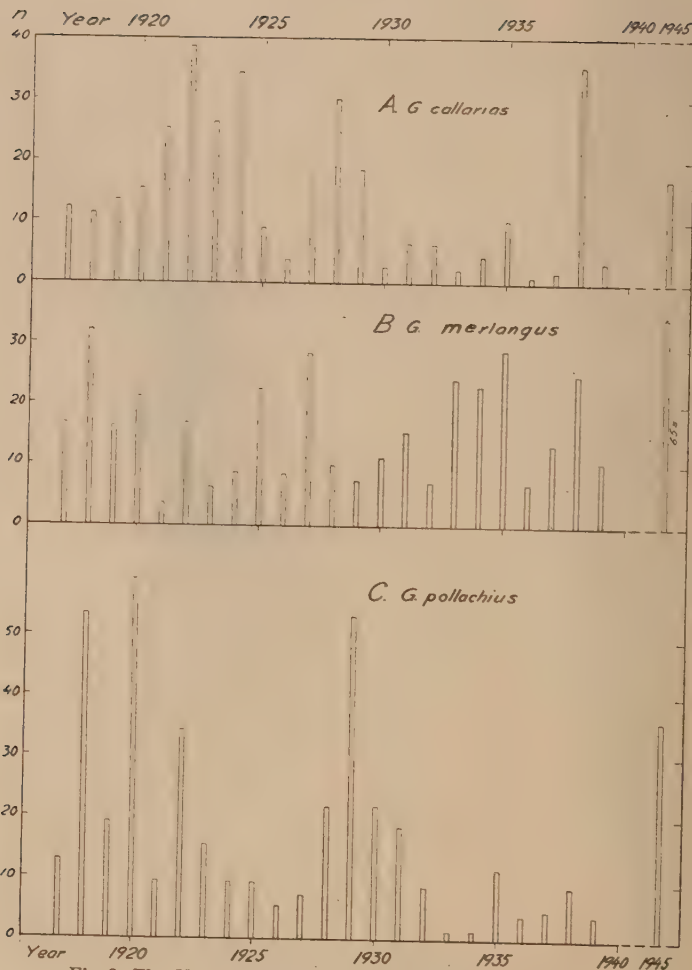


Fig. 2. The Norwegian Skagerak Coast. Number of 0-Group per Haul in the Littoral Region.
(Mean of approximately 75 hauls pr. year.)

inity between 27.9 ‰ and 29.3 ‰. The temperature of the water from the surface to a depth of 10 metres is close to the freezing point.

A temperature of about 1.0° below zero is detrimental to most fishes. If the water is cooled from the surface and the low temperatures spread downwards the fish will have a chance to avoid the cold water and sink down in the deeper parts of our fjords, in the skjærgård or in the deeper parts of the Skagerak. Sometimes, however, the cold water is pressed towards the coast by easterly winds and great numbers of fish may then be taken by surprise and will succumb. This is especially the case with young year-classes of cod, pollack and green cod living in the littoral region. But also great quantities of other small fishes living in the littoral region will succumb.

The littoral fauna on the whole will also very reduced — both by the low temperature, accumulated fresh water and the direct action of the ice. As the larvae of those littoral animals and grown-up individuals, serve as food for food fishes, the very cold winters may be of importance for our commercial fisheries.

The Cod Fishes.

The Fig. 2 illustrates the occurrence of half-year-old cod, whiting and pollack in the littoral region of the Norwegian Skagerak coast between Kragerø and Mandal. The results given are the mean of about 75 hauls made with a sm seine every year in the same season. The observations had to be discontinued during the w

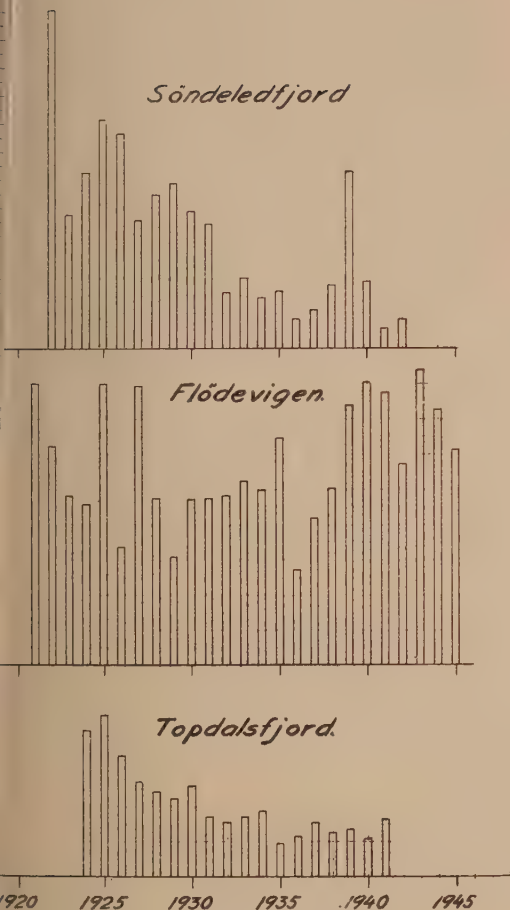


Fig. 3. Number of Cod per Trap per Year.

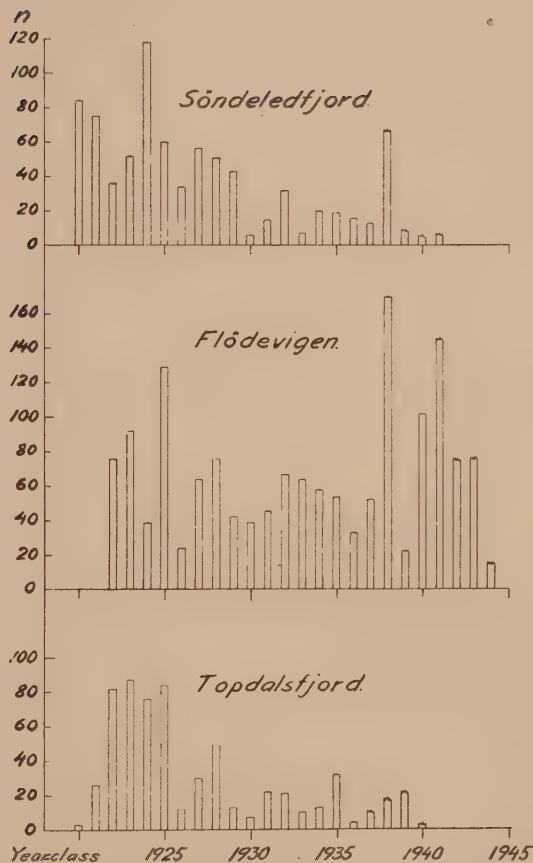


Fig. 4. Total Number of Cod of each Year-Class caught in one Trap.

the cod the values found for the last years are quite ordinary except for 1938, when we had a very rich year-class especially in the eastern districts. This is due to the fact that the cod are catching occur in relatively great numbers in the fjords and the pollack was also numerous.

Fig. 3 illustrates the annual catches of cod using fishing gear in two fjords and in the skjærgård (Flødevigen) on the Skagerak coast. It will be seen that the catches are keeping at the same level in the skjærgård, but in the fjords the catches are declining. This seems to indicate that the stock of young cod mostly caught is kept at a low level height in the skjærgård. In the fjords, however, it may be taken for granted that the stock is declining during the last decades. It is noted, however, that we have no observations from the fjords since 1941.

The Fig. 4 illustrates the occurrence of each year-class in the same district. The values for the last years are not representative. The year-class 1938 was extraordinarily rich in the eastern part of the coast, in Söndeledfjord and at Flødevigen. In Topdalsfjord the occurrence was quite ordinary. Comparing 1924 and 1925 it is also evident that other year-classes differ widely in relative abundance in the different places. The rich year-class 1938 has been dealt with separately.

The fishing for pelagic fish eggs and larvae started that year on the 21. of February. The number of cod larvae caught on each station in the waters outside Arendal are as follows:

Egg-net, 4 horizontal hauls, each of 10 minutes

at 0, 10, 20 and 30 metres. Larvae-net (in brackets), two hauls of 20 minutes at 10 and 30 metres.

Skagerak					
	Galtesund	S.E. off Torungen light,	in naut. m.		
	1	5	10	15	
Feb.					
21—22	0(NB)	0(NB)	0(NB)	0(NB)	0(NB)
April					
11—12	48(125)	22(60)	0(2)	0(8)	—
May					
13	—	5 ¹⁾ (49)	0(0)	1(5)	—
20	2(2) ²⁾	1(5)	—	—	—

¹⁾ two hauls only with the egg-net.

²⁾ but 10 minutes.

NB: no hauls.

It will be seen that the larvae occurred in great numbers in the skjærgård and close to the coast in the middle of April. But practically none in the coastal current.

In the Oslofjord we have worked some stations in five years. The number of cod and haddock eggs is given in Dannevig 1945*), Fig. 25. In the inner fjord we got plenty eggs in March, they were all in early stages. In this area we never find cod eggs in late stages, the eggs apparently do not develop in this area owing to the unfavourable conditions of the water during spring. In April we had a high number of eggs in late stages in the outer part of the fjord. Outside Ferder there were few eggs in both months. The number of cod larvae is given in the following table. The numbers refer to 16 hauls with egg-net and 8 hauls with larvae-net (in brackets).

Oslofjord.				
	1936	Inner part 1937	1938	1939
March	1 (NB)	1 (NB)	1 (NB)	0 (NB)
April	1 (0)	1 (1)	17 (4)	0 (0)
May	0 (0)	22 (0)	32 (36)	0 (6)
Total	2 (0)	24 (1)	50 (40)	0 (6)
Outer part				
March	10 (NB)	11 (NB)	19 (NB)	57 (NB)
April	14 (6)	30 (2)	143 (64)	13 (2)
May	0 (81)	9 (21)	3 (190)	9 (81)
Total	24 (87)	50 (23)	165 (254)	79 (83)

NB: no hauls.

In 1938 the cod larvae were especially numerous in April and May, both in the inner and outer fjord.

During the summer the small cod were ob-

served along the Skagerak coast. Their behavior was quite extraordinary, they occurred in shoals and fed close to the surface, especially on *Anomolocera patersoni* which that year was specially abundant.

The number of vertebrae has been counted 7600 specimens of that year-class.

The number of vertebrae of the 1938 year class in its first summer is the following: (in brackets).

Inner Oslofjord	51-95	(1046)	ε	0-02416
Outer "	52-00	(2361)	ε	0-01592
Skagerak Coast	52-05	(2221)	ε	0-01647

The difference between the inner fjord and the Skagerak coast is significant. In the Oslofjord and on the eastern part of the Skagerak coast the number of vertebrae is somewhat higher, on the western part somewhat lower than ordinarily found.

The first working hypothesis as to the origin of the rich brood appearing in the Oslofjord along the Skagerak coast was that it was brought into our waters by the current from the inner Skagerak. The pelagic habit of the young made very reasonable to assume such an inflow of "international" young fish.

The examination of the material confirms the theory, the number of vertebrae is more uniform than normally is the case, and points to the fact that the young cod apparently are of the same origin. The differences found, e.g., between the inner Oslofjord and the Skagerak coast indicate however the presence of local stocks.

My assistant, Mr. Løversen, who has collected the material, and I, finally arrived at the following conclusion: The spring of 1938 has been very favourable to the development of the cod (and haddock) eggs in these waters. The rich brood originates largely from spawnings outside our fjords, but the high number of larvae and young fish with a relatively low number of vertebrae in the inner Oslofjord, and in the small fjords of the Skagerak coast indicates a successful breeding of the local stocks.

As to the conditions being relatively favourable for the hatching of the eggs and the survival of the larvae that year we are of the opinion that two points are to be specially mentioned.

1. The sea-temperature was low in the early winter. This postpones the spawning till the plankton has developed.
2. Westerly winds prevailed during spring keeping the brackish surface layers away from the coast. The cod eggs will then float nearer the surface, and get more light. From the Hatchery at Flødevigen it is known that light (and sunshine) is favourable for the hatching and for the larvae.

*) Undersøkelser i Oslofjorden 1936—1940.

Lobster.

Fig. 5 the results are given of the lobster for a certain number of fishermen for the years 1928 to 1945 for the district Jomfruland to Risør. In the eastern and middle district the catch is extraordinarily high in 1945. This may be the result of easy circumstances during the fishing season. From September 16th and onwards the weather was dominating. The catches at Skjærgård, however, were also far greater than normal. And as here the fishing operations were disturbed by stormy weather it is probably the chief cause for the rich fishing is sought in the stock itself.

Lobster caught is normally of an age of 1-2 years. In years with low sea temperatures growth will be very much retarded and in years with high temperatures the growth will be accelerated. During the last years it will be seen from Fig. 1 that the temperature anomalies generally are positive. More year-classes will then occur in the stock of the grown-up lobster. Normally the case and temporarily at the catches.

During ice winters sometimes great losses may occur among the lobsters kept in floating boxes. As ascribed by the fishermen to the low temperature of the seawater. By experiments it has been shown that the lobster is very resistant to low temperatures. The mortality may rather be ascribed to the fresh water accumulating under the ice the lobster being very sensitive to low sal-

Oysters.

During the cold winters a heavy loss of grown-up oysters occurred on the oyster beds in 1939—

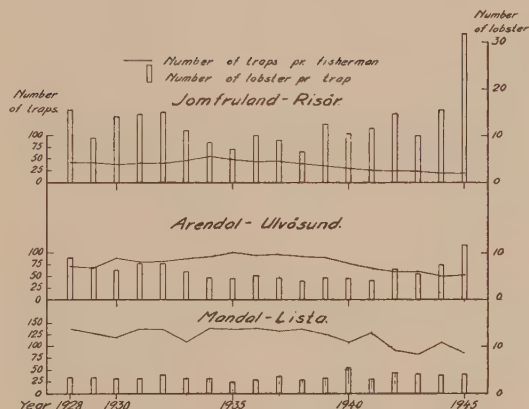


Fig. 5. Lobster-Fishing on the Norwegian Skagerak Coast.

1940. This was ascribed to the low temperatures. But as no mortality at all occurred in the following winters 1940—41 and 1941—42 — when the temperature of the sea was still lower — the mortality in 1939—40 must be explained in another way.

In the oyster pond at Flødevigen a good quantity of oysters survived in 1941—42. At a depth of one metre the temperature was below 0°C . from Jan. 8. to March 27. and colder than -1°C . on the days Jan. 12. to Jan. 16. and Jan. 28. to Febr. 18. The lowest temperature observed -1.7°C ., occurred on Febr. 9. at a depth of 2 metres below the surface. The basin was covered by ice from Dec. 15. 1941 to April 20. 1942.

Sweden.

The Haddock Fishery off the West Coast of Sweden, 1935—39 and 1940—44.

By

Arvid R. Molander.

THE present paper on the haddock fishery off the west coast of Sweden is based upon statistics of landings at Göteborg received from the offices of the fishery harbour. The landings of haddock at Göteborg comprise about 80 % of all catches of haddock made by the fishermen of Bohuslän; they give therefore a good representative idea of the size and changes of the Swedish haddock fishery during the years under review.

The landings of haddock at the Göteborg fishery harbour during 1935—39 (Fig. 1) were comparatively uniform, with the exception of a remarkable increase in 1938. This year, 4,714,310 kg. were landed whereas the landings in the other years varied between 3,217,608 kg. and 3,778,578 kg.

Fig. 2 shows the composition of the catches during the years mentioned above. It will be seen that an overwhelming quantity of the so-called "small" haddock (about 28—38 cm.) was caught. Large haddock (about 40—60 cm.) and medium (about 33—45 cm.) made together only about 12—22 % of the catches. Especially large haddock

are not numerous (4—6 %). The smallest are mostly sent to the fish-meal factories, and generally not included in the catch statistics of fishery harbour.

If we examine the distribution of the catches as to fishing grounds (Fig. 3) we find that the haddock fishery was mainly carried out in the North Sea. The Hanstholm area comes next and then follow the waters off Hirshals and the section Skaw—Haken—Väderö islands. Commercially significant catches were made in the deep southern part of the Skagerak (Måseskär—Hamnskär) and in the northern Kattegat (given in Fig. 4 under "others").

In the haddock fishery from 1940 to 1944 (Fig. 4) the very strongly reduced landings during 1941—42 are instantly obvious, as well as a remarkable increase in 1943. 1944 also shows comparatively good landings, compared with the first three years of the war. The strict limitation of the fishery account of the war — especially the blockade of the North Sea — explains of course the decline in the landings of haddock during 1941—42.

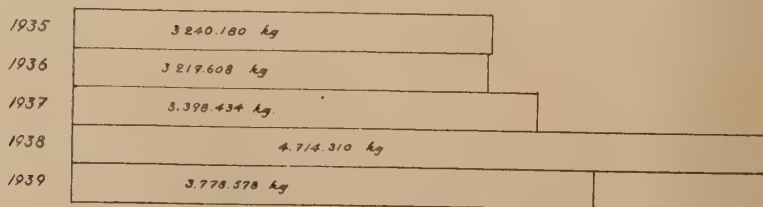


Fig. 1. The Landings of Haddock at Göteborg Fishery Harbour, 1935—39.

compared with 1935—39. But the fact that increase of landings could take place during 1943—44 in spite of the intensified military operations cannot be explained but by an improved haddock — both as to quantity as quality — proceeds to the east and has reached farthest waters Hanstholm — Hirshals — the Skaw. —6).

composition of the haddock catches 1940 shown in Fig. 5. Compared with the pre-war period a great rise in the catch figures of medium and large haddock will be seen. In 1941 small haddock were still landed in completely large quantities, but they were later displaced by the larger categories. The medium haddock dominate especially in 1942, but also of importance in 1943 and 1944. Medium haddock prevail in 1944, but show high catch also in 1941 and 1943. Generally speaking, a considerable increase in large haddock has taken place in the fishing grounds under review during the war years, subject only to minor variations in the differing strength of the various years.

Table 1 below is given in connexion with Fig. 6 and shows the percentage distribution of the haddock categories during the 5-year periods 1935—39 and 1940—44.

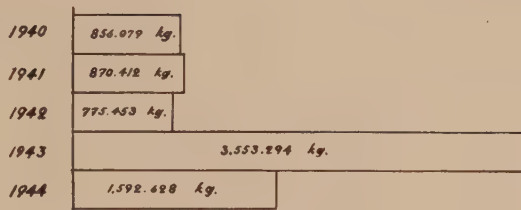


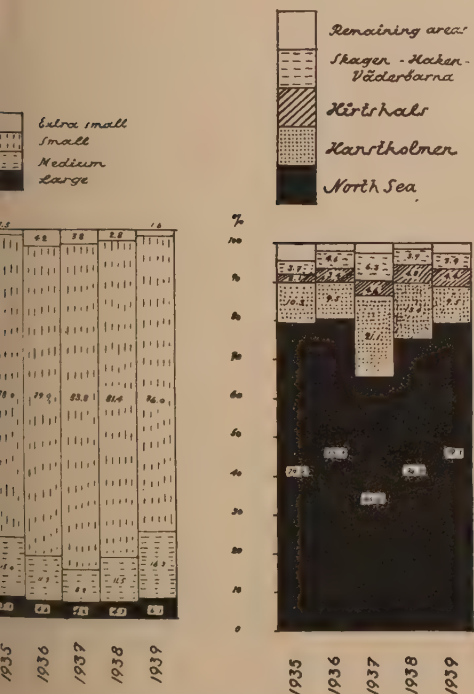
Fig. 4. Landings of Haddock, 1940—44.

Table 1.

Percentage Distribution of various Size-Groups of Haddock landed at Göteborg in 1935-39 and 1940-44.

Category	1935-39	1940-44
Large haddock	4.9 0/0	27.7 0/0
Medium haddock	12.4 0/0	31.1 0/0
Small haddock	79.9 0/0	36.9 0/0
Undersized haddock	2.8 0/0	4.3 0/0

Fig. 6 shows the distribution within the fishing grounds of haddock catches landed during 1940—44. As late as 1940—41 some catches from the North Sea were landed. They were mostly fished in the waters neighbouring the Skagerak and just



Catches 1935—39.



Catches 1940—44.

Fig. 2. Composition.

Fig. 3. Distribution.

Fig. 5. Composition.

Fig. 6. Distribution.

off the Norwegian coast. From 1942 the fishery in the North Sea was wholly suspended; fishing was almost entirely restricted to the waters off Hanstholm, Hirtshals and the Skaw. In 1943 and 1944 the fishery was further displaced towards the east, on account of extended mine barrages and a more severe action taken by the Germans. Also from those waters given under "others" increasing catches were reported during the war years, and an eastwards movement of denser shoals of haddock towards the Skagerak and Kattegat was evident. *The good haddock fishery, for instance from 1943 to 1944, is thus exclusively based upon a strongly increased stock within the Skagerak in the first case, and next the Kattegat.* This appears clearly from Tab. 2 showing the total landings at Göteborg, during the two 5-year periods, of catches from the more important fishing grounds in the North Sea, the Skagerak and the Kattegat. It will be seen how strong is the increase — in absolute figures also — in the quantities caught in the waters of the Skagerak and the Kattegat during the years 1940—44. The supplies from the southern Kattegat show decrease, if any.

If we examine more closely the length distribution of haddock within the various fishing grounds (Fig. 7) we find, compared with 1939 for instance in all waters from the North Sea to the Skaw, a distinct increase in the occurrence of large and medium haddock and almost everywhere uniform variations from one year to the other. In the demersal channel off the coast of Bohuslän (district of Måskär and Hamneskär—Vinga) the changes in the categories during the war were smaller, but here there used to be present a comparatively large percentage of larger haddock, taken in relation to haddock occurrence generally. Neither in the northern nor in the southern Kattegat do the differences in the size distribution of landed haddock seem to have been great, for instance in 1939 and the following war years. But here also a large percentage of medium haddock was evident in 1944. The landings from the southern Kattegat were generally small and the catches were decreasing, anything; and it seems as if the effect of the increased occurrence of haddock in Swedish waters had not yet reached that far in 1944.

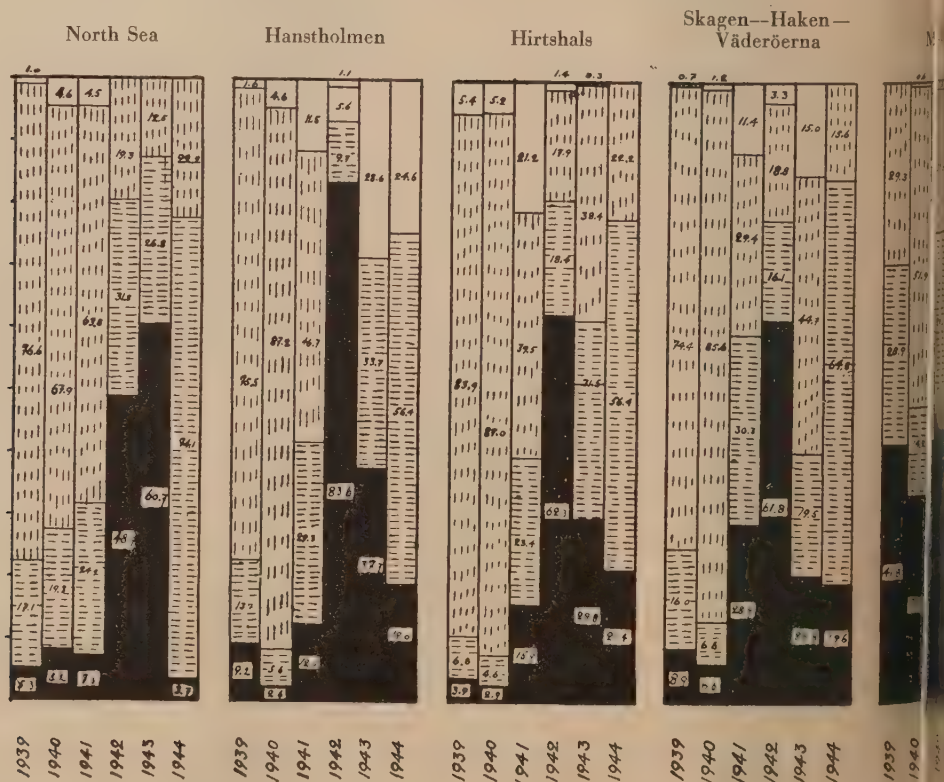


Fig. 7. The Length Distribution

Table 2.

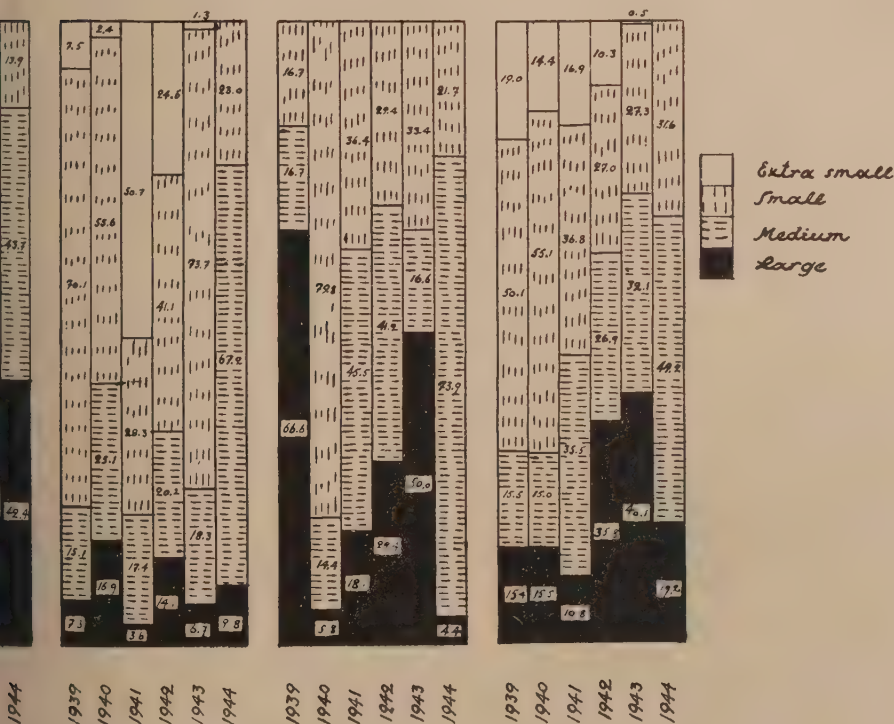
Total Landings of Haddock (kg.), 1935-39 and 1940-44 at Göteborg Fishery Harbour,
from the most important Fishing Grounds in the North Sea,
the Skagerak, and the Kattegat.

Area	1935-1939	0/0	1940-1944	0/0	Increase 0/0	Decrease 0/0
North Sea	13,985,874	76.2	517,816	6.8	—	96.3
Hanstholmen	2,340,633	12.8	2,519,763	32.9	7.7	—
Hirshals	723,529	3.9	2,238,118	29.3	209.3	—
Skagen Waters	810,045	4.4	1,450,316	19.0	79.0	—
Måseskär Waters	39,686	0.2	93,693	1.2	136.1	—
Hamneskär—Vinga	47,811	0.3	219,802	2.9	359.7	—
Northern Kattegat	77,053	0.5	231,277	3.0	200.1	—
Southern Kattegat	8,276	—	7,856	0.1	—	5.1
Others	316,203	1.7	369,225	4.8	16.8	—

Varberg—Anholt—
Koppargrund—Tistlarne
—Nidingen—Læsø

Kullen
Halmstadbay

Remaining
Areas



The Stock of Herring in the Skagerak and the Kattegat during 1941—1945.

By

K. A. Andersson.

THE herring caught by Swedish fishermen in the Skagerak and the northern part of the Kattegat consist chiefly of the following three "races" or "populations": (a) an autumn-spawning herring with about 56·35 vertebrae and large central areas in the scales. It spawns generally in the waters around Groves Flak and the "Koppar"-ground in the central Kattegat. (b) The large spring herring of the Kattegat with about 57 vertebrae and small or medium central areas in the scales. It spawns in the waters of Groves Flak and in the "Skärgård" of northern Bohuslän late in winter or early in spring. (c) The bank herring of the North Sea which has been of great importance for the Swedish catches specially during the last two years. It spawns in autumn; the number of vertebrae is about 56·50, and there are as a rule small central areas in the scales. Besides, an autumn-spawning form is sometimes found in the catches which has a low number of vertebrae — 56·05—56·20 — and large central areas. In the southern Kattegat as well as north and south of Anholt Knob autumn-spawning herring are found in the catches which have an even lower number of vertebrae.

As mentioned in my paper "The Stock of Herring in the Sound and the Southern Baltic in the Years 1940—1944" (see this vol., p. 166) the year-class from the autumn of 1937 was abundant in the herring catches in the Sound during the years 1940—41 and it dominated strongly in the southern Baltic still during 1944. It is therefore interesting to know whether this year-class was also rich in the Kattegat and the Skagerak.

A catch made on 25. VIII. 1942 in the waters of Anholt Knob in the southern Kattegat contained

an *autumn-spawning herring* with a low number of vertebrae (55·74) where the 1937 year-class strongly predominated (54 %). It was then 5 years old (see Fig. 1).

In the above-mentioned autumn-spawning form with 56·05—56·20 vertebrae the same year-class predominated in the Skagerak and the northern Kattegat. During the years 1941—44 it constituted 44—55 % of the catches; it was then 4—7 years old (see Fig. 2). This high percentage of the year-class from the autumn of 1937 is actually not of special importance for the Swedish fishery because this form is only very scarce in the Swedish landing catches.

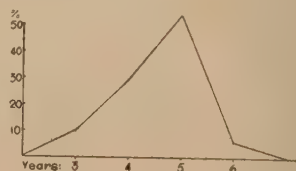
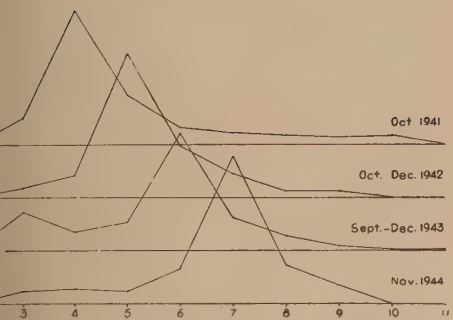


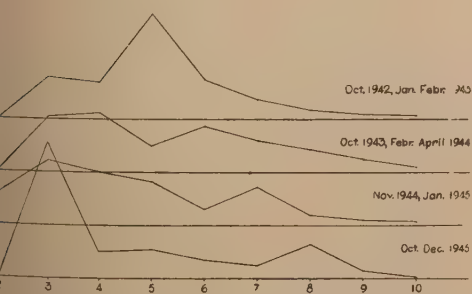
Fig. 1. Herring, autumn spawners, No. of vertebrae 55·74, from the southern Kattegat, Anholt Knob, August 1942. Age-composition.

Fig. 3 shows the age composition of the most important "race", the autumn-spawning herring from the Kattegat, during the years 1942—45. The 1937 year-class was comparatively strong in the autumn of 1942 when it was 5 years old. During the following three years it can still be traced in the curves. But it has undoubtedly never been abundant (taking absolute values) in the Skagerak and the Kattegat, because in that case it should have caused an increase in the fishery yields, which, however, did not occur. The fishery of this herring has been very poor during the years



Herring, autumn spawners, from the Skagerak and northern Kattegat. No. of Vertebrae 56-05—56-20. Age-composition 1941—1944.

5. Any other strong year-class has not appeared. The curve for October and December 1945 shows a high percentage for the three-year-old fish. It is long to a new year-class from the autumn of 1944 and may cause an increase in the stock of 1945, but nothing definite can as yet be said. The *spring-spawning herring* a strongly dominant year-class has not occurred during the period 1942—44 (Fig. 4). In the beginning of 1942 three-year-olds (three summers) were quite represented (41%). They belonged to the year-class from the spring of 1939. A new year-class often show high percentages, but it does not necessarily become of special importance during the next years. During the period September 1942 to March 1943, that is, after a period of 1941 it did not assert itself to any special degree but it can be followed as five and six-year-old fish during the next two years. During the period September 1942 to March 1943 a new three-year-class (from the spring of 1940) appeared in the catches, but it did not develop to any extent during the next years.



Herring, autumn spawners, from the Skagerak and northern Kattegat. No. of Vertebrae 56-35. Age-composition 1942—1945.

Summarizing we may say that, during the period 1941—45, the "races" which spawn in the Skagerak and the Kattegat have not produced any really prolific year-class which might have increased the fishery yields to any considerable degree.

In the beginning of 1944 a change occurred in the herring stocks of the waters north and west of the Skaw and between the Skaw and the Swedish west coast. The so-called *North Sea bank herring* appeared for the first time in the catches in much larger quantities than before. The landings were much greater in January, February and March than during the same months of the preceding years.

This herring was generally mixed with the spring and autumn-spawning herring from the Kattegat and occurred even off the Swedish coast and in the northern part of the coast of Bohuslän and even within the skerries. On the other hand, it hardly enters the Kattegat. In recent years it has rarely proceeded farther south than to Måseskär light.

In three samples from the area of the Skaw and off the Swedish west coast in January and February 1944 the number of vertebrae was 56-56, 56-58 and 56-48.

During the first months of 1945 bank herring occurred in increasing quantities in the Swedish catches — these consisted often of up to 50—70% of bank herring.

Five catches from the area in question, caught in January, March and April 1945 proved to have the following number of vertebrae: 56-50, 56-47, 56-49, 56-47, and 56-48. The number agrees well with the vertebral number of the *North Sea bank herring*.

In September 1945 the Swedish fishermen carried out extensive herring trawling on the Fladen Ground in the North Sea. Two samples of catches taken there on the 5th and 20th were analysed; their vertebral number was 56-51 and 56-54. In the sample from the 5th only a few herring had

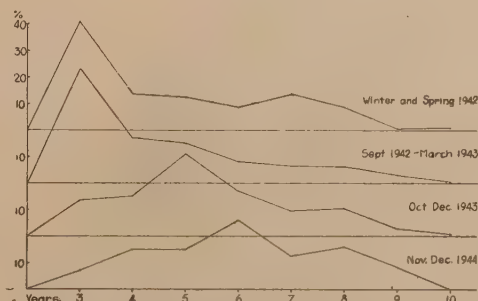


Fig. 4. Herring, spring spawners, from the Skagerak and the Kattegat. No. of Vertebrae 56-91—57-18. Age-composition 1942—1944.

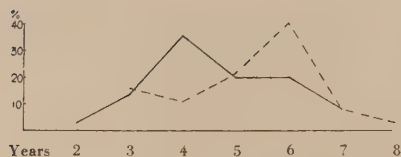


Fig. 5. Herring from Fladen Ground.
Age-composition 1945.
— Sept. 5th, 1945.
- - - " 20th, 1945.

spawned, but in that from the 20th 37% were already spent. Most of the herring had small central areas in the scales. In January and February 1946 three samples were analysed which had been caught by purse seine between the Skaw and Måse-skär light at the Swedish coast. The number of vertebrae was 56·56, 56·56 and 56·49. The scales had generally small central areas.

It therefore seems to be beyond doubt that it is really North Sea bank herring that occur during the winter in the waters north and north-west of the Skaw and from the Skaw to the Swedish coast.

As soon as the herring have spawned some-

where in the Fladen Ground region, viz., in September and October, they scatter and some migrate (following the current) to the Skagerak, pass the Skaw and proceed to the Swedish coast where they are caught. To the eastern Skagerak they do not come in any larger numbers before the latter half of December and January. There they remain, at any rate a part of them — until the end of March and the beginning of April when they migrate back to the North Sea.

As a result of the more abundant occurrence now of bank herring there are caught more bank herring than previously in the eastern Skagerak.

The question as to what are the causes of this rich occurrence of the bank herring in the eastern Skagerak during the last two years is difficult to answer. Large-scale hydrographic investigations could unfortunately not be made during the winter. The increasing immigration of bank herring might possibly be due to an increase in the water current that goes from the North Sea to the Skagerak at the Swedish coast. But the increased immigration may also be a result of a denser stock of bank herring. In support of this explanation might be taken the fact that the 4 and 6-year-old year-classes were fairly dominant in the catches of September 1945 (see Fig. 5).

The Growth of the Sprat at the West Coast of Sweden g the Cold Winters 1940—42 and some Notes on the Great Coastal Fishery for Sprat during February-March 1943.

By

Arvid R. Molander.

I. Growth of the Sprat.

In the first issue of the *Annales Biologiques* (1943) I have already shown how extraordinarily small were the sprat of the Uddevalla in the autumn of 1940 (loc. cit., Tab. 7). Compared with the previous years, the growth in length, chiefly of the I-group, had considerably decreased during 1940. The scales also showed very small summer zones in 1940 (l. c., Fig. 8). The hydrographical station in the inner part of Gullmar Fjord exceptionally low temperatures of the water at 0 and 20 m. depth were recorded in the spring and early summer of 1940 (l. c., Fig. 9). In the above-mentioned paper I suggested that the cold winter of 1940 and the resulting very low temperatures of the water in the various fjords had influenced the growth of the sprat.

It is well known, the 1940 winter was followed by two cold winters of 1941 and 1942; the latter especially lasted very long and the cold was

Of the species which were followed year after year throughout these "wolf" winters, the sprat was generally small. A more detailed study of the growth-rate of the sprat during these years — in the fjords as well as in the open sea (Skagerak) — gives evident proof of the influence of the winter conditions upon its growth.

Table 1 gives the mean length of the sprat from Gullmar-Fjord, November to December, 1936—1943 (l. c.). If we divide these years into two periods — 1936—39 and 1940—42 — and compare the mean length of the several age-groups of these years we find considerable differences, i. e.,

	I-Gr.	II-Gr.	III-Gr.
1936—39	11.9—12.7	13.1—13.8	14.3—14.8
1940—42	10.8—11.6	12.4—12.9	13.4—13.8

The decrease of the growth-rate during 1940—42 is thus very obvious, even if it changes somewhat during the various years. This decrease affects all age-groups and is not least in the older ones (II and III). The mean length of the II-group in 1940—42 is for instance hardly greater than that of the I-group in 1936—39. A similar agreement exists between the average lengths of the II-group in 1936—39 and of the III-group in 1940—42.

In 1943 the winter conditions are more normal; the sprat of the Gullmar-Fjord show markedly higher growth increments than in the directly preceding years. See Tab. 1, mean lengths in the Gullmar-Fjord during 1940—43 (Nov.—Dec.). The

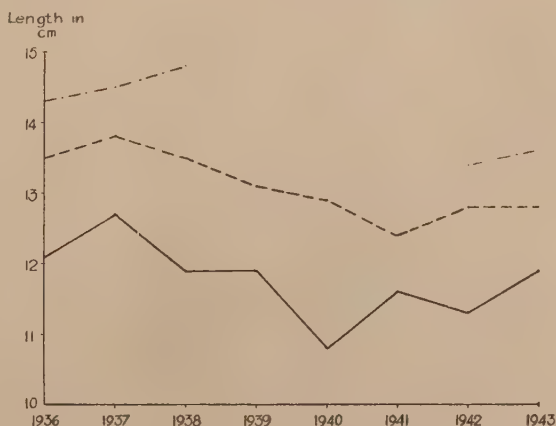


Fig. 1. Mean Length of Sprat from the Gullmar Fjord, Nov.—Dec., 1936—1943.

I-Group —————
II-Group - - - - -
III-Group - · - · -



Map of the Bohuslän "Skärgård".

ing growth, of the I-group above all, seems to be the changing character of the various and the variations within this age-group re- clearly the yearly variations which have been ed in the hydrographical conditions during ring and early summer of the relevant years (also p. 87).

Table 1.
Mean Lengths of Sprat in the Gullmar Fjord,
Nov.—Dec., arranged in Age-Groups.

Groups	Year			
	1940	1941	1942	1943
I-Gr.	10.8	11.6	11.3	11.9
II-Gr.	12.9	12.3	12.8	12.8
III-Gr.	13.8	—	13.4	13.6

Figs. 2 and 3 are given the mean lengths of sprat from the Marstrand Fjord and from the sea (Skagerak). The heavy decline in the growth-rate during the years 1940—42 compared with that of former years is evident, even in the sea. In Fig. 2 — Marstrand Fjord — the increasing length in 1943 of the I-group is also

is. When we examine the growth-rate of various year-classes during the periods 1935—37 and 1939—41 we clearly see the slower growth of those year-classes that have passed through the cold winters 1940—42. The 1939 year-class shows thus the slowest growth: it has passed through all winters. Clearly, though less strikingly, is diminished growth seen in the 1940 and 1941 year-classes. The generally much stronger growth of the year-classes 1935—37 (Fig. 4) shows but one exception, that of the 1937 year-class as III-Gr. But that growth took also place during the

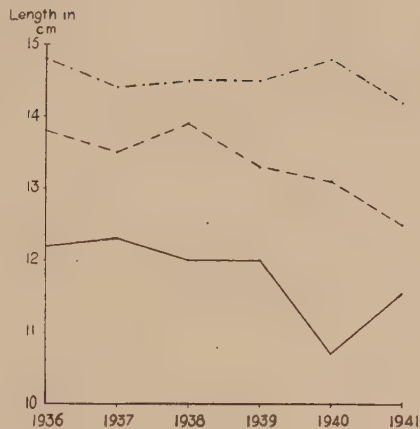


Fig. 3. Mean Length, Skagerak (open sea), Nov.—Dec., 1936—1941.

I-Group —————
II-Group - - - - -
III-Group - · - · -

year 1940 which from a hydrographical point of view had the coldest winter.

Summarizing we may thus say that all year-classes, the chief development of which fell during the years 1940—42, suffered a strong decline in growth-rate during these years. The size of the I-group is more than any other exposed to variations and influenced by the special conditions of the various years. Furthermore, each year-class seems to have a growth-rhythm of its own (Tab. 2) depending chiefly upon the growth during the first and second years (0 and I-groups). The check

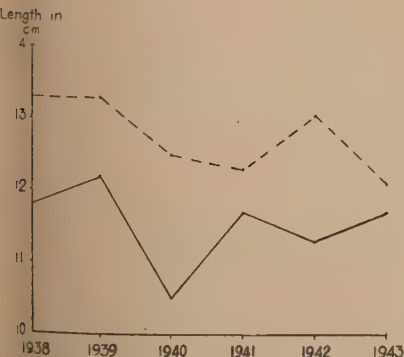


Fig. 2. Mean Length, Marstrand Fjord, Nov.—Dec., 1938—1943.

I-Group —————
II-Group - - - - -

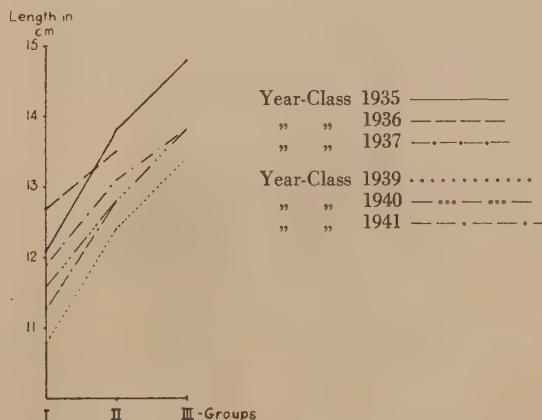


Fig. 4. Growth-Rate of various Year-Classes, Gullmar Fjord.

upon the growth which occurred in the above-mentioned years during the earliest growth period of the sprat could practically not be made up for during the later periods.

A phenomenon which has often been observed in the growth-rate of the sprat is the fact that slow growth during a certain year, as I-group for instance, is usually followed by a relatively quicker growth during the next year. This holds good also for the year-classes 1939—41. Tab. 2 further shows that even if the growth of the II and III-groups of these year-classes was not generally much slower than that of earlier year-classes (1935—37), the strongly reduced growth during the first year could not wholly be compensated by an often relatively strong growth later on. This must undoubtedly be ascribed to the special conditions under which the sprat lived during the years 1940—42.

The examples given here have been taken from the sprat of the Gullmar Fjord, but similar conditions obtain in a similar extent in other waters (Marstrand Fjord, Skagerak, the open sea) (see Tabs. 3 and 4).

II. The Influence of the Cold Winters upon the Growth of the Sprat during 1940-1942.

Both at the Gullmar Fjord (Bornö) and in the Kolje Fjord the year 1940 reached throughout the lowest mean values at 10 and 20 m. depth, and 1941 brings an obvious increase in the temperatures at 10 and 20 m. In 1942, the mean temperatures decrease again (comp. Environment, p. 88). These variations correspond perfectly to the annual variations in the mean length of the sprat during the years 1940—42 which have been discussed above, and correlated with the variations in the hydrographical conditions.

I have already mentioned that the extraordinary hydrographical conditions during the winters of 1940—42 must have caused the slower growth of

the sprat. But how is it that the winter conditions could exert such a strong influence upon the annual growth increments of sprat of various fjords? In another paper (Molander 1946) I have shown that the slowest growth of the sprat occurred during the spring months (February to June). The abnormally low temperatures of the sea water during these months of 1940—42 have in all probability deferred the time for the start of a growth-period and thus considerably shortened length. How sensitive the sprat and its growth rate is to such temperature conditions appears from the fact that the growth variations during the years 1940—42 run parallel to the changes in the hydrographical conditions (see p. 87—88).

Table 3.

Mean Lengths from the Open Sea (Skagerak) Nov.-Dec. arranged in Age-Groups.

Age-Group	Year				
	1936	1937	1938	1939	1940
I	12.2	12.3	12.0	12.0	10.7
II	13.8	13.5	13.9	13.3	13.1
III	14.8	14.4	14.5	14.5	14.8

Table 4.

Mean Lengths from the Skagerak, Nov.-Dec. arranged in Year-Classes.
(Growth Increments in brackets).

Year-Class	Age-Group		
	I	II	III-Gr
1935	12.2 (1.3)	13.5 (1.0)	14.8
1936	12.3 (1.6)	13.9 (0.6)	14.8
1937	12.0 (1.3)	13.3 (1.5)	14.8
1938	12.0 (1.1)	13.1 (1.1)	14.8
1939	10.7 (1.8)	12.5 —	—

III. Variations in the Annual Growth Increments of Sprat during several Years and within several Year-Classes.

In chapter I it was shown that the average length of the age-groups that had developed during the cold winters was considerably below normal. In this chapter the changes in the growth-rate are more closely examined by aid of the growth increments in each year calculated from the information according to Lea's method (Lea 1900). For the examination I have chiefly taken material from the Uddevalla fjords where the sprat has a very uniform growth type and where the influence of the special conditions during the cold winters 1940—42 seems to have been strongest.

Table 2.

Mean Lengths of Sprat in the Gullmar Fjord, Nov.-Dec., arranged in Year-Classes.
(Growth Increments in brackets.)

Year-Class	Age-Groups		
	I-Group	II-Group	III-Group
1935	12.1 (1.7)	13.8 (1.0)	14.8
1936	12.7 (0.8)	13.5 —	—
1937	11.9 (1.2)	13.1 (0.7)	13.8
1939	10.8 (1.5)	12.3 (1.1)	13.4
1940	11.6 (1.2)	12.8 (0.8)	13.6
1941	11.3 (1.5)	12.8 —	—

Table 5.

Mean Lengths of Sprat at a Series of Stations within the Uddevalla Fjords and their Growth Increments (in cm.).

Date	L	g_1	g_2	g_3	No. of Ind.	Age- Group	Year- Class
27/9 1935	11.3	7.6	3.7		20	I	1934
18/10 1935	11.2	6.9	4.3		25	I	1934
	11.2	6.5	3.9	0.8	21	II	1933
20/11 1939	11.6	6.8	4.8		32	I	1938
	11.9	7.1	4.0	0.8	24	II	1937
29/10 1940	10.1	8.1	2.0		30	I	1939
24/10 1941	11.3	6.3	5.0		72	I	1940
	11.4	7.5	2.3	1.6	27	II	1939
4/11 1941	11.1	6.2	4.9		45	I	1940
	11.5	7.3	2.4	1.8	28	II	1939
5/11 1941	10.3	5.5	4.8		39	I	1940
	10.6	6.3	2.2	2.1	11	II	1939

From Table 5 it will be seen that the mean lengths of the sprat from 1940—41 are generally greater than for instance those from 1935 and 1939 in the I-group as well as in the II-group. Annual growth increments (g_1 , g_2 , g_3) within various year-classes show striking differences. Especially obvious is the small increment of the second year, the g_2 -growth, in the 1939 year-class, in samples taken in 1940 and 1941. It is followed by an extraordinary rapid g_3 -growth in 1941 (1.8 against 0.8 cm.). Even though such alternation between slow and quick growth are characteristic of the sprat, this case is still remarkable. In other variations are not quite so great, but obviously low values were observed in 1933 and in 1939. The latter year had a very cold winter; it is only natural, as mentioned above, that the prevailing extraordinary hydrographical conditions would have influenced the sprat in its first year's growth. The low g_1 -value in 1933 may be the result of the formation of a very dense year-class.

Table 6 sets out more clearly the slow g_2 -growth in 1940 of the 1939 year-class and the comparatively slow g_1 -growth of the 1940 year-class; both cases may, as mentioned above, be attributed to the extraordinary conditions of 1940.

The combined growth increments of the first and second year ($g_1 + g_2$) of the year-classes 1939 and 1940 are remarkably smaller than those of the other year-classes given in the table, with exception of year-class 1933 which must have been a result of the special conditions that gave rise to an extremely strong year-class. The combined values of $g_1 + g_2 + g_3$ of year-class 1939 give also a low length value.

The different appearance of the scales formed during the varying growth conditions is even at a first glance clearly visible, as for instance the striking difference between the I-Group scales of Fig. 5 (a broad g_1 -zone from 1939 and a narrow g_2 -zone from 1940) and the scale of Fig. 6 (a narrow g_1 -zone from 1940 and a broad g_2 -zone from

Table 6.

Size of the Growth Increments in cm. within several Year-Classes of Sprat from the Uddevalla Fjords. (Growth-year in brackets).

Year-Class	g_1	g_2	g_3	$g_1 + g_2$	$g_1 + g_2 + g_3$
1933	6.5 (1933)	3.9 (1934)	0.8 (1935)	10.4	11.2
1934	7.2 (1934)	4.0 (1935)	—	11.2	—
1937	7.1 (1937)	4.0 (1938)	0.8 (1939)	11.1	11.9
1938	6.8 (1938)	4.8 (1938)	—	11.6	—
1939	7.3 (1939)	2.2 (1940)	1.8 (1941)	9.5	11.3
1940	6.0 (1940)	4.9 (1941)	—	10.9	—

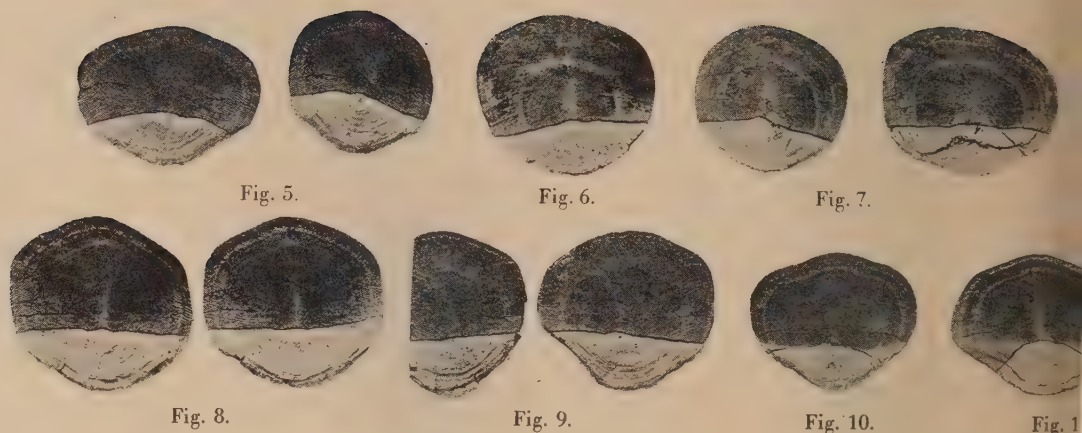


Fig. 5—11. Sprat Scales.

Photo: A. R. Mol.

Fig. 5. Sprat 10.5 cm., I-Group, Hafsten Fjord, 29/10, 1940.
 " 6. " 11.5 " I-Group, " " 4/11, 1941.
 " 7. " 10.5 " II-Group, " " 4/11, 1941.
 " 8. " 11.0 " II-Group, Hake Fjord, 25/9, 1941.

Fig. 9. Sprat 10.5 cm., II Group, Hafsten Fjord, 29/10, 1940.
 " 10. " 10.0 " II-Group, Hake Fjord, 25/9, 1941.
 " 11. " 11.0 " II-Group, " " 25/9, 1941.

1941). Even if the 1941-type with a comparatively broad g_3 -zone (Figs. 7 and 8) predominates among the 1939 year-class, in isolated instances other types also are found (Fig. 9) where the second and the third-growth zone have a more normal width. It is also of some interest to note that in 1941 a great number of sprat from the Hake Fjord had scales of the same type which characterized the sprat stocks from the Uddevalla fjords (Fig. 10). Fig. 11, however, shows a sprat from the Hake Fjord which has had a more normal growth. This latter type predominates in that fjord. The occurrence of two types of sprat in the Hake Fjord in 1941 seems to give evidence of an emigration of sprat from the Uddevalla fjords to the Hake Fjord, as has been observed before in several in-

stances, but it does certainly not preclude the possibility that, in certain cases, the ice winter of 1940 exerted its influence also upon the growth of sprat of the Hake Fjord.

Table 7 gives a summary of the extent of annual growth of the year-classes 1939—42, derived from a series of age analyses of samples taken in the Gullmar Fjord during the years 1941 and 1943. Extraordinary annual growth as in the sprat of the Uddevalla fjords is not to be found here, but the low aggregate value of the annual growth increments during the cold winters of the year-classes 1939—41 is obvious. Year-class 1942, on the other hand, shows another growth-rate, but this year-class was not so much influenced by the cold winters.

Table 7.
 Annual Growth Increments of several Year-Classes of Sprat from the Gullmar Fjord.
 (Five samples from 1942-43).

Year-Class	g_1	g_2	g_3	g_4	$g_1 + g_2$	$g_1 + g_2 + g_3$	$g_1 + g_2 + g_3 + g_4$
1939	5.8	4.3	2.1	1.2	10.1	12.2	13.4
1940	6.7	4.1	2.1	1.1	10.8	12.9	14.0
1941	5.7	5.1	2.7	—	10.8	13.5	—
1942	7.0	5.3	—	—	12.3	—	—

The Relation between the Size of the at and the Strength of the Year-Classes.

In my papers from 1940 and 1942 I have shown that the average size of the various year-classes seems to depend, to a certain degree, upon the strength of the year-classes. Rich year-classes have a lower growth-rate, i.e., the sprat is smaller; poor year-classes have a higher growth-rate, and the sprat grows larger. One example has already been given, i.e., the strong 1933 year-class, which is mentioned (Tab. 6) very low growth increments. The 1933 year-class was also dense, both in the Uddevalla fjords and in the Skagerak, and its mean size was small (Molander 1940). Among the year-classes of later years that of 1939 was the densest and predominated strongly during 1940 and 1941, both in the Uddevalla fjords and in other waters. It may well be that the abundance of the year-classes of this year-class has been one of the causes of its very conspicuously low growth-rate, although the above-mentioned hydrographical conditions have undoubtedly been the decisive factors regarding its growth during 1940—42. Other than the specially rich year-class seems to have occurred during these years. The 1941 year-class was fairly good, but not nearly so predominant as that of 1939.

Even though the influence of the varying growth of the several year-classes upon the average growth-rate of the sprat must not be neglected, the hydrographical factors discussed above seem to be the foremost to have decided the growth during the severe ice-winters.

V. The great Sprat Fishery in the Skerries of Bohuslän. February to March, 1943.

During the winter of 1943 — especially the months February and March — a record fishery took place within the skerries in the immediate neighbourhood of Säcken and Strömstad as well as in the outer part of the Gullmar Fjord and adjoining waters; it is the largest fishery within the skerries, so far as records go (see Tab. 8). Normally, fishing is insignificant at this time of the year.

The autumn fishery of 1942 had been relatively good and mostly concentrated at the Marstrand Fjord (Tab. 9), Hake Fjord and the area of Mollösund. In the Uddevalla fjords it was moderate and in the Gullmar Fjord it did not start until the late autumn.

After New Year the fishing declined very heavily in the area Marstrand—Mollösund, but increased in the Gullmar Fjord and adjoining waters (Tab. 9).

Furthermore good catches (560,520 kg.) were taken during January and February in various waters (Bro Fjord, Malmö Fjord, Trelebergskilen) in the neighbourhood of Lysekil. The first maximum in Gullmar Fjord occurred between February 2nd and 8th, another very strong one between Febr. 23—26, and in March without interruption from the first to the 20th (Tab. 10). Compared with the autumn, the increase is very great and in January—March the fishing within the fjord exceeded the whole sprat fishery of the autumn of 1942, very good though that fishery had been. The fishery

Table 8.

Sprat landed at various places in Bohuslän.
(according to statistics from Göteborg fish harbour).

Landed at	Within the Skerries		Outside the Skerries
	16/8-42—2/1-43 kg.	3/1-43—10/4-43 kg.	Trawled kg.
Marstrand	59,895	—	27,855
Klädesholmen	1,427,220	4,149	49,322
Uddevalla (13/7 42—2/4 43)	245,609	2,070	—
Fiskebäckskil	357,990	48,750	—
Lysekil	731,160	3,325,590	19,350
Gravarna, Smögen	218,340	171,450	389,790
Grebbestad	—	24,750	—
Strömstad	58,509	3,159,531	71,809
Total	3,098,723	6,736,290	558,126

Grand Total 9,835,013

At the fish market of Göteborg 6,725,876 kg. were landed, most of them trawled

in the Gullmar Fjord during January—March is the largest ever recorded there. After it had finished in the fjord it continued for some days off Gullholmen as well as out to Karingö Fjord and S. of Mollösund. Many, some very primitive, methods were used for catching the fish. Even floating trawls were used, originally by fishermen from Grundsund, in which a trawl was dragged at the surface by two smaller or larger boats. The result was very satisfactory, and according to data received from fishermen, about 500,000 kg. sprat are said to have been caught in this way in the Gullmar Fjord alone.

Within the area of Strömstad the fishing was sometimes even more concentrated. While having been insignificant in January 1943 (Tab. 11) — executed chiefly by trawl outside the skerries — between February 4th and 9th, the sprat began gradually to enter the outer part of the skerries (Öddö, Käbblingen). The fishing continued then at Långörännan and Holmengrå and after February 12th it concentrated during two shorter periods (Febr. 15—18 and 22—26), mostly at Säcken and Dynekil. A look at the map shows that coming from the west the sprat enter the outer parts of the skerries (Öddö—Käbblingen) and later on the inner part of the skerries (Långörännan—Holmengrå) and then spread in great masses to Säcken and Dynekil.

This February fishery at Säcken and in the other waters near Strömstad is the largest one ever experienced within the skerries of Bohuslän at any time of the year. During March 1943 it decreased sharply and the sprat were mostly trawled.

This extraordinarily large migration to the above-mentioned fjords during January—March 1943 is of very great interest, and it is natural to look into its causes. In the first place it is necessary to analyse the sprat catches made outside the skerries. Tab. 12 gives the catches (chiefly trawled) landed at Göteborg during November—March of

Table 10.

Catch of Sprat in the Gullmar Fjord 1943.

	January kg	February kg	March kg
1	—	—	18.0
2	—	9,900	207.0
3	—	15,300	126.0
4	15,030	32,580	117.0
5	7,740	13,500	225.0
6	—	3,600	324.0
7	—	10,440	—
8	6,480	14,580	72.0
9	—	—	36.0
10	—	—	45.0
11	12,420	—	54.0
12	9,900	—	40.5
13	5,680	13,500	42.7
14	6,750	—	42.7
15	10,440	14,400	54.0
16	—	—	21.1
17	—	—	38.2
18	—	—	22.5
19	—	—	22.5
20	29,250	43,200	—
21	19,350	—	2.1
22	11,520	—	—
23	5,580	22,500	—
24	—	144,000	—
25	12,150	270,000	—
26	16,110	405,000	—
27	33,210	—	—
28	24,390	—	—
29	—	—	—
30	—	—	—
31	—	—	7.0
	226,000	1,012,500	1,517.0

Total 2,756,440 kg.

Table 9.

Important Fishing Grounds for Sprat landed in Bohuslän during the autumn of 1942.

Fishing Ground	Catch in kg.
Marstrand Fjord	1,510,470
Hake Fjord	71,190
Around Klädesholmen	75,150
	1,656,810
Käringö Fjord }	322,110
Kräksundsgap }	
Brofjord	24,430
Gullmar Fjord	233,226
Uddevalla fjords	245,609
Dynekil, Skärgård of Strömstad	58,326

1939—43. The bulk of the trawled sprat was landed during these months, principally November—January.

The table shows that the fishing season 1943 (November—March) gave very heavy catches, even compared with the years 1939—42. Note the decrease in the fishery during 1940, 1941, and 1942 as a result of the heavy ice during the winter months. The singularly strong trawling during January 1943 is also remarkable; it is unparalleled by any other year. This month's great fishery outside the skerries corresponds to a relatively heavy immigration of sprat to the Gullmar Fjord (Tab. 10). In February—March, however, the catches from outside the skerries decrease to a

Table 11.

Catch of Sprat in the Area of Strömstad, January-March 1943 (landed at Strömstad).

Väder- öarna	Fjäll- backa	Febr.	Väder- öarna	Oddö, Käbb- lingen	Långorännan, Holmengrä	Säcken, Dynekil	March	Väder- öarna	Säcken	Bovall- strand
kg.	kg.		kg.	kg.	kg.	kg.		kg.	kg.	kg.
		1	—	—	—	—	1	—	—	—
		2	—	—	—	—	2	—	765	—
		3	—	—	—	—	3	—	—	—
		4	1,350	3,600	—	—	4	4,050	—	—
		5	1,197	720	—	—	5	—	—	—
		6	—	—	—	—	6	—	—	—
225	1,530	7	—	—	—	—	7	—	—	—
1,035	—	8	—	11,745	—	—	8	—	1,080	—
42,300	—	9	432	151,605	—	—	9	162	—	3,600
—	—	10	—	—	362,655	—	10	—	—	—
—	—	11	—	—	53,100	—	11	—	—	—
1,008	—	12	—	—	1,530	—	12	—	—	—
180	—	13	—	—	—	—	13	—	—	—
108	—	14	—	—	—	—	14	—	—	—
—	—	15	—	—	—	383,400	15	1,530	—	—
—	—	16	—	—	—	606,600	16	—	—	—
—	—	17	—	—	48,645	416,700	17	—	—	—
—	—	18	—	—	—	13,500	18	270	—	—
—	—	19	—	—	—	—				
135	—	20	—	—	—	—				
10,863	—	21	—	—	—	—				
450	—	22	—	—	—	586,665				
—	—	23	—	—	—	376,965				
—	—	24	—	—	—	25,605				
—	—	25	—	—	—	27,225				
—	—	26	—	—	—	16,650				
—	—	27	—	—	—	—				
81	—	28	—	—	—	—				
270	—									
—	—									
—	—									
56,655	1,530		2,979	167,670	465,930	2,453,310		6,012	1,845	3,600
Trawled)			(Trawled)					(Trawled)		
Total 58,185 kg.			Total 3,089,889 kg.			Total 11,457 kg.				
Grand Total 3,159,531 kg.										

Table 12.

Catch of Sprat landed at Göteborg, Nov.-March, 1939-1943.

	1939/40	1940/41	1941/42	1942/43
Nov.	863,915	579,975	459,960	1,255,413
Dec.	2,443,095	1,244,300	1,127,815	1,051,225
Jan.	1,658,031	97,250 ice	729,205	3,388,857
Febr.	276,950 ice	52,150 ice	981,917 ice	188,535
March	161,450 ice	633,835	22,126 ice	132,297
	5,403,441	2,607,510	3,321,023	6,016,327

Table 13.

Distribution of Sprat according to Length-Classes within several Age-Groups and Gonad Stages.

(a) From Strömstad (Saltbanken), 15.II.1943.

(a) From Stromstad (Saltbanken), 18.IV.1948.																	
Age-Group	Length in cm.																Mean Length
	7.5	8	8.5	9	9.5	10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15.5	
I	1	4	9	2	1	—	—	—	—	—	—	—	—	—	—	—	8.4
II	—	—	—	1	4	8	12	23	9	7	1	1	—	—	—	—	10.9
III	—	—	—	—	—	—	—	—	1	4	1	1	2	2	—	—	12.7
IV	—	—	—	—	—	—	—	—	—	—	—	1	2	1	1	1	14.0
	1	4	9	3	5	8	12	23	10	11	2	3	4	3	1	1	
Stages of Gonads																	
1	1	4	9	2	1	2	5	6	1	—	—	—	—	—	—	—	9.5
2	—	—	—	1	4	6	7	17	9	11	2	3	4	2	1	—	11.5
3	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	14.8
	1	4	9	3	5	8	12	23	10	11	2	3	4	3	1	1	—

(b) From the outer part of the Gullmar Fjord, (Skaftö), 23.II.1943.

Age-Group	Length in cm.											Mean Length	Total
	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5		
II	2	7	3	7	2	1	—	—	—	—	—	11.5	22
III	—	—	1	1	—	4	1	3	—	—	—	13.1	10
IV	—	—	—	1	1	5	2	4	4	2	—	13.7	19
V	—	—	—	—	—	—	—	1	—	—	1	14.8	2
	2	7	4	9	3	10	3	8	4	2	1		53
Stages of Gonads													
1	—	1	—	—	—	—	—	—	—	—	—	11.0	1
2	2	6	4	9	2	9	3	8	3	1	1	12.7	48
3	—	—	—	—	1	1	—	—	1	1	—	13.8	4
	2	7	4	9	3	10	3	8	4	2	1		53

insignificant level, if compared with the directly preceding months, and simultaneously the unusually great immigrations take place to the Gullmar Fjord and the skerries of Strömstad. There is reason to believe that the immigrations to the above-mentioned area of skerries and fjords were recruited from the stock of sprat from outside the skerries which was hereby markedly diminished. The catch statistics regarding the grounds where the fish, landed in Bohuslän, was caught mention besides NE. of Hirshals mostly the flat W. of the Väder islands and W. of Hamneskär; it is probable that the great immigration to the skerries has started from this area and was directed chiefly to the Gullmar Fjord and to the waters off Strömstad where the greatest fishing concentrations occurred.

The immigration to the Gullmar Fjord continued even until March. This direction of the migration may perhaps be correlated with the currents off the coast of Bohuslän during these months. It is surprising that no appreciable immigration could be observed to the Marstrand Fjord where fishing had been so abundant in 1942.

The causes of the great sprat fishery in Norway—March 1943 must undoubtedly be ascribed to the great immigrations to the coastal waters; these again must primarily be assumed to be caused by the very dense stock of sprat which have occurred outside the skerries, judged from abundant trawl-fishing carried out during November—December 1942 and January 1943. Analysis of the biological material tells us, however,

13 continued).

) From the Mouth of the Gullmar Fjord, 3.III.1943.

Age-Group	Length in cm.															Mean Length	Total
	9	9.5	10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5			
II	1	1	5	10	22	7	10	2	—	—	—	—	—	—	11.1	58	
III	—	—	—	—	—	—	1	2	1	2	—	—	—	1	13.2	7	
IV	—	—	—	—	—	—	1	—	1	1	3	1	2	—	13.9	9	
VI	—	—	—	—	—	—	—	—	—	—	—	—	1	—	15.0	1	
Stages of Gonads	1	1	5	10	22	7	12	4	2	3	3	1	3	1		75	
	1	—	1	2	2	4	1	1	—	—	—	—	—	—	10.7	11	
	2	1	—	3	8	17	5	10	2	2	2	1	—	3	11.5	54	
	3	—	—	—	—	1	1	1	2	—	1	2	1	—	13.1	10	
	1	1	5	10	22	7	12	4	2	3	3	1	3	1		75	

) From Bro Fjord, 9.III.1943.

Age-Group	Length in cm.															Mean Length	Total
	9.5	10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16			
II	1	3	15	30	13	14	3	—	—	—	—	—	—	—	11.4	79	
III	—	—	—	—	—	—	—	5	1	—	—	1	—	—	13.3	7	
IV	—	—	—	1	—	—	—	—	2	7	1	—	—	1	13.8	12	
V	—	—	—	—	—	—	—	—	—	—	—	1	—	—	15.0	1	
VI	—	—	—	—	—	—	—	—	—	—	—	—	1	—	15.5	1	
	1	3	15	31	13	14	3	5	3	7	1	2	1	1		100	
Stages of Gonads																	
1	1	2	5	3	1	—	—	—	—	—	—	—	—	—	10.5	12	
2	—	1	10	25	10	12	2	1	—	1	—	1	—	—	11.3	63	
3	—	—	—	3	2	2	1	4	3	6	1	1	1	1	13.2	25	
	1	3	15	31	13	14	3	5	3	7	1	2	1	1		100	

e) From Hirshals, 17.III.1943 (outside the skerries).

Age-Group	Length in cm.													Mean Length	Total
	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5			
II	1	—	3	3	2	—	—	—	—	—	—	—	12.2	9	
III	—	—	—	2	2	4	8	2	—	—	—	—	13.6	18	
IV	—	—	1	—	3	2	14	18	18	3	1	—	14.7	60	
V	—	—	—	—	—	—	—	2	4	3	3	1	15.3	13	
	1	—	4	5	7	6	22	22	22	6	4	1		100	
Stages of Gonads															
1	1	—	—	—	—	—	—	—	—	—	—	—	11.0	1	
2	—	—	—	1	2	—	1	2	2	—	—	—	13.9	8	
3	—	—	4	3	3	4	13	12	14	6	4	1	14.3	64	
4	—	—	—	1	2	2	8	8	6	—	—	—	14.2	27	
	1	—	4	5	7	6	22	22	22	6	4	1		100	

that several exceptions to normal conditions have taken place, chiefly perhaps regarding the migrations during January—March: in other years, they were in the opposite direction, away from the coastal waters.

During the great fishery the stock of sprat in the fjords consisted chiefly of the year-class 1941 which was almost two years old and is therefore given in the tables as II-group (Tab. 13). The percentage of this group varies between 40 and 80 %. It is more interesting, however, that even older sprat (III and IV-group) are much more abundant in the inshore stocks than they used to be. It is also remarkable that the IV-group (the 1939 year-class) shows such a relatively high percentage (6—19 %). This year-class must have been very rich and it predominates even in the stock outside the skerries (Tab. 13e). It has undoubtedly been of great importance for the strong development of the sprat stock during the years 1942—43, next to the 1941 year-class.

In another connexion I have already pointed out that during 1940—42 the sprat showed a definite, though during the various years a somewhat varying decrease in growth-rate. This is also proved by the material of Tab. 13. All the age-groups (II—IV) have a much lower average length than usual.

The sprat from the Strömstad waters were generally the smallest. Sprat caught in the Skagerak (Hirshals) show higher mean lengths for several age-groups, but this must partly be due to the fact that the smaller fish from several groups had emigrated and come in to the coast and the fjords. These slow-growing sprat of various year-classes are about the same size as those which normally enter the fjords in autumn — mostly fish of the 0-group.

This decrease in growth which occurred during the years with cold winters is of biological importance from another point of view also. The small size of the sprat has caused the gonads of both the II and older age-groups to be retarded in their development. As a result, more fish of these age-groups remain in their first stage of development, i.e., they are immature, and, in fact, a general retardation has taken place in the development of the gonads during the spring months of 1943. Table 13a shows that among the sprat of February 1943 the Strömstad sample has a very large percentage of first-stage fish, even among those belonging to the II-group. The sprat were

very small, but in the majority the gonads were the 2nd stage. The same refers to the sprat from the Gullmar Fjord of February (13b). In the beginning of March a somewhat larger percentage of fish with gonads in the 3rd stage is found, for instance in the sprat of the Gullmar Fjord (13c) and the Bro Fjord (13d). Compared with sprat caught about simultaneously at Hirs (Tab. 13e) the sprat fished within the skerries clearly seen to be not only less advanced in the sexual development, but also to be on an average of a much smaller length. It thus seems as if smaller and the sexually least developed sprat have migrated from outside the skerries into the fjord. Under normal conditions the sprat have usually left the fjords and the "Skärgården" by February—March, to pass through a short sexual development ending with spawning in the coastal waters outside. No greater quantity of sprat has before been seen in the fjords at this time of year, and the immigration observed in February—March is quite exceptional. But we know now the determining circumstances. Outside the skerries a very large stock of sprat arose consisting of both younger and older year-classes, among which those of 1939 and 1941 predominated. The sprat were generally small and the age-groups II to IV had mostly an average length hardly larger than that found in sprat at the normal time of immigration. In these small sprat the development of the gonads was also clearly retarded, a fact which seems to have been a contributing factor to the migration to the coast which the larger and more developed sprat otherwise seem to avoid. The purely biological causes of the migration to the skerries and the mouths of the fjords seem thus to have been present. In the middle and at the end of March when the gonads have developed further, the sprat have left the "Skärgård" waters. It must also be noted that this strong migration during February and March 1943 did not reach the inner parts of the fjords, but only their mouths and the outer skerries. This is probably connected with the fact that the sprat never enter deep into the fjords shortly before spawning; it reminds us of the observations made somewhat later in the spring immediately before and during spawning: the sprat which are now ripe penetrate often into the mouths of the Gullmar Fjord, but never into the fjord itself. The same biological causes seem to be at work here as during spawning off most of the other fjords (Molander 1940).

The Sprat Fishery and the Hydro- nical and Meteorological Conditions m November 1942 to March 1943.

is only natural to ask whether special hydro-
nical and meteorological conditions during late
n 1942 and the winter months 1943 have
rted the above-mentioned strong migrations
rat — especially during the first months of

examination of the meteorological and hy-
nical conditions during this period does
resent any specially remarkable features.
inter was certainly mild and — as usual in
cases — variable winds were recorded, most-
om south and west. As a result, hydrogra-
conditions in the sea were also variable,
water flowing alternately into the fjords and
gain (Molander 1940). It is probable
greater mobility of the coastal water layers
ded the movements of the sprat to and from
ords. In order to give better evidence of a
le correlation between the result of the fish-
n the fjords and the meteorological and hy-

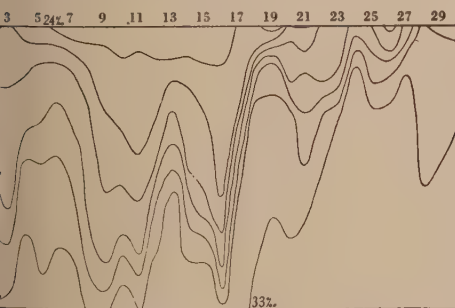


Table 15.
Catch of Sprat in the Gullmar Fjord, in January
1943, together with Wind and Currents.

Date	Wind	Catch (kg.)	Date	Wind	Catch (kg.)
1	—	—	17	—	—
2	NNE. 3	—	18	S. 7	—
3	N. 6	—	19	S. 5	—
4	N. 8	15,030	20	S. 4	29,250
5	N. 8	7,740	21	NE. 3	19,350
6	N. 2	—	22	NE. 3	11,520
7	N. 4	—	23	N. 4	5,580
8	NE. 4	6,480			65,700
9	N. 1	—	24	—	—
10	N. 3	—	25	SSE. 6	12,150
11	NE. 4	12,420	26	SSE. 9	16,110
12	N. 4	9,900	27	SSE. 2	33,210
13	E. 6	5,680	28	S. 3	24,390
14	NE. 4	6,750			85,860
15	NE. 4	10,440	29	SSE. 8	—
16	NW. 2	—	30	SSE. 4	—
			31	—	—
		74,440			151,560
					Total 226,0000

makes the following hydrographical remarks: "From the 3rd there is an inflow of salt bottom water which culminates on the 6th and reaches to 10 m. Later on, this water is forced out again and substituted chiefly by water below 26 ‰ reaching from the surface to 15 m. depth. On the 11th follows a minor invasion of bottom water which is driven out again on the 16th. At that date an enormous wave sets in of water of 32—33 ‰ which at the end of the month ascends to the surface."

The marked increase of the fishery on November 7th and directly following days is evidently a result of the inflow of salt bottom water, which started on the 3rd and culminated on the 6th. The fishery was further strengthened by a minor invasion of bottom water on the 11th culminating on the 13th. On the 16th, this invasion is thrown back and simultaneously the fishery is very strongly diminished. The enormous wave of 32—33 ‰ which starts in the next days is followed by a new occurrence of sprat which seem to remain during the rest of the month as long as the salt water wave stays in the fjord.

It must be noted that the fishery seems to start with an ingoing as well as an outgoing current. When the isohalines slope steeply downwards, i.e., when the salt water that suits the sprat best, is forced in to or out of the fjord, the conditions for a good fishery in the fjord seem to be present. The fishery can thus also be carried out after the height of the culmination, i.e., when the salt water is flowing out.

During the inflow of the salt water at the beginning of the month, from the 7th to the 11th and 13th southerly and south-westerly winds were blowing. During the later half of the month northerly winds predominated simultaneously with invasion of the salt water wave.

December 1942. — Table 14 — This fishery was chiefly characterized by the fact that fish was almost wholly concentrated in the outer parts of the fjord while in the beginning of the month and in November it had been carried out in inner parts.

Dr. Jonsson comments Fig. 13 as follows:

"The month started with a small inflow of 33 ‰ water from the 1st to the 3rd which already begun on November 28th. Otherwise, the month is characterized by a gradual outflow of cold water which fills the fjord. An insignificant inflow of bottom water occurred on the 15th and 23rd—26th."

At the beginning of the month (Tab. 14) the fishery took place simultaneously with the inflow of 33 ‰ water. This inflow had evidently influenced the fishery during the last days of

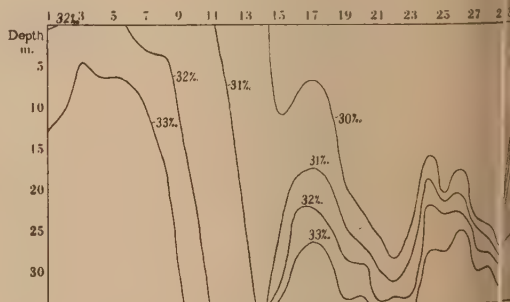


Fig. 13. Isohalines, Bornö, Dec. 1942.

vember. During the gradual outflow of this water the fishery is strongly diminished, but it increases again when the saltier bottom water flows in on the 15th—17th — chiefly in the outer parts of the fjord. The sporadic fishery on the 27th may particularly be related to the inflow of saltier bottom water between the 23rd and the 26th.

During the inflow of the saltier water in the beginning of the month northerly winds prevailed and easterly winds during the fishery in the middle of the month. Southerly winds occurred on the end of the month.

January 1943. — Table 15 —

As to the hydrography of January Dr. Jonsson says: "On the 3rd, a strong bottom current of 33 ‰ water started which reached on the 11th to 3 m. After this day the salt water was driven out with great velocity and exchange."

Table 16.

Catch of Sprat in the Gullmar Fjord, February-March, 1943, together with Wind and Currents.

February			March		
Date	Wind	Catch (kg.)	Date	Wind	(Catch kg)
1	SE.	6	1	NNW.11	18,000
2	SE.	7	2	NNW.17	207,000
3	SE.	3	3	N.	7 126,000
4	SE.	2	4	—	117,000
5	SE.	1	5	SW.	3 225,000
6	S.	11	6	NE.	6 324,000
7	—	—	7	—	—
8	—	14,580	8	SSW.	5 72,000
9	SE.	4	9	SSW.	4 36,000
10	S.	1	10	SSW.	8 45,000
11	SE.	7	11	WSW.	6 54,000
12	SSE.	8	12	W.	8 40,500
13	N.	7	13	—	42,750
14	NW.	1	14	—	42,750
15	SW.	6	15	S.	3 54,000
16	—	—	16	S.	3 21,150
17	—	—	17	S.	1 38,250
18	WSW.	8	18	—	22,500
19	SW.	6	19	NE.	6 22,500
20	NNW.	16	20	N.	5 —
21	—	—	21	—	2,340
22	SW.	5	22	—	—
23	SW.	3	23	E.	2 —
24	SW.	7	24	NE.	5 —
25	SW.	5	25	—	—
26	WSW.	7	26	NE.	4 —
27	W.	9	27	E.	3 —
28	—	—	28	—	—
			29	WSW.	4 —
			30	SW.	8 —
			31	W.	8 7,200
1,012,500			1,517,940		

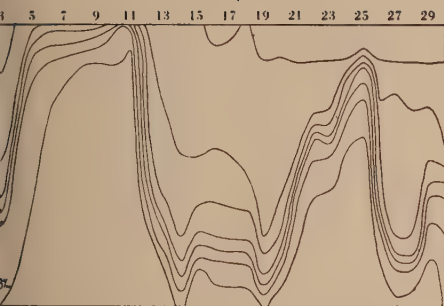


Fig. 14. Isohalines, Bornö, Jan. 1943.

the water. Water of 26 ‰ salinity had gone down to 25 m. Then the bottom rose again on the 25th to 15 m. and was exchanged for water of 26—28 ‰ salinity from 10—25 m."

The fishery on the 4th and 5th, and even on the 6th might be the result of this strong inflow of salt water, which started on the 3rd. The great height of this salt-water wave lasting to the 11th further brought a strong invasion of sprat. The fishery continued for some days while simultaneously the isohalines showed a steep fall and salt water was forced out of the fjord; during the days 16th—19th when the salt bottom wave disappeared the fishery ceased. Simultaneously with a new bottom wave starting on the 20th the fishery improved remarkably and continued as long as the salt water was present and even — as at the beginning of the month — while the isohalines showed a steep fall during the outflow of salt water from the inner parts of the fjord. The fishery took place in the outer parts of the fjord and the culmination of the outflow of the bottom wave was probably somewhat retarded so this may explain the continued fishery, after the salt bottom water had left the inner parts of the fjord. The concentration of the fishery at the time of the two marked and strong periods of inflowing salt bottom water is, however,

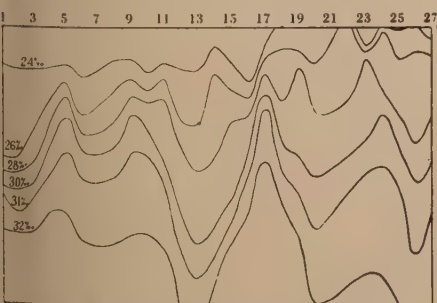


Fig. 15. Isohalines, Bornö, Febr. 1943.

very obvious. The conditions of the wind are characterized by predominating N. and NE. winds and some S. and SE. winds at the end of the month.

February 1943. — Tab. 16 —

The fishery shows two important maxima: at the beginning of the month, on the 2nd and the 8th and at the end on the 23rd and the 26th. And in between there were good catches on the 13th, the 15th, and the 20th.

Dr. Jonsson characterizes the hydrographical situation as follows: "On the 2nd began a slight inflow of salt water which advances chiefly between 15 and 25 m. and which turned on the 10th when the fjord received in its place a minor addition of 24—28 ‰ water between 5 and 15 m. On the 14th occurred a new invasion of bottom water which brought the 30 ‰ water on the 17th up to 8 m. An inflow followed starting between 10—15 m. but afterwards going downwards so that on the 24th the 33 ‰ water was driven out and

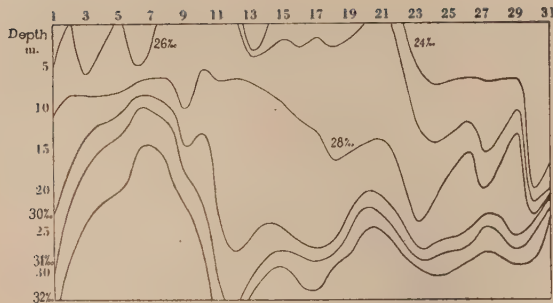


Fig. 16. Isohalines, Bornö, March 1943.

between 10 and 30 m. the fjord contained 30—32 ‰ water. During the last days of the month the situation was not quite clear.”

Together with the inflow of salt water between the 2nd and the 8th a very good fishery took place which ceased as soon as the salt water went out of the fjord on the 10th and the immediately following days. The inflow between the 14th and the 17th seems to have caused a more sporadic fishery in the middle of the month (13—15). Then the fishery decreased together with the outflow of the salt water. The inflow of salt water culminated on the 17th — but there was no fishing. The culmination probably took place somewhat earlier in the outer part of the fjord. The great fishery at the end of the month must be supposed to have been due to the inflow of 30—33 ‰ water on the 21st to 24th and the fishery continued until the 26th within a water layer where the in and outflow was only slightly noticeable. It must be mentioned here that the strong fishery at the end of the month hardly can have been caused by any specially remarkable inflow of salt water layers. But it was easier for the great sprat shoals off the coast to enter the fjord than at a time when the inflow was strongest. SW. and S.E. winds predominated during the month.

March 1943. — Table 16 —

Dr. Jonsson's remarks on the hydrographical situation are as follows: — (Fig. 16) “The first week was dominated by a strong inflow of salt water which reached its maximum on the 6th. During the rest of the month the salt water kept very low. The 28—30 ‰ layer spread downwards from 13—27 m. during the 9th to the 12th, and then water of 26—28 ‰ was brought in at 1.5—15 m. until the 18th. During the last week the changes were insignificant.”

If we correlate the fishery with the hydrographical conditions we observe first the extraordinarily rich fishery on the 2nd to the 6th together with a strong inflow of salt water which, as with the fishery, had its maximum on the 6th. Then the fishery diminished considerably, but continued to give good, though decreasing catches until the

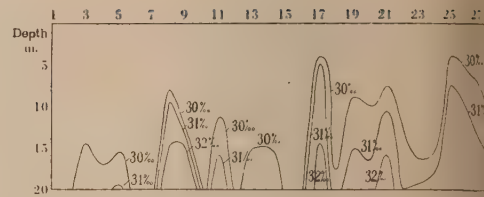


Fig. 17. Isohalines, Dynekilen, Febr. 1943.

19th when it was almost finished. This happened simultaneously with the outflow from the fjord of the salt water. During this time, the fishery shifted more and more to the outer and farthest parts of the fjord. Considerable amounts of sprat were probably fished when leaving the fjord. It is possible that the strong inflow into the fjord of water between 28 and 30 ‰ salinity was one of the causes which made the sprat stay somewhat longer in the fjord. But when this water was driven out of the fjord after the 18th the fishery ceased. On the 31st the saltier bottom water commenced to rise, and the same day brought a sporadic fishery. The winds during the month were variable.

What has been said above about the relation between the sprat fishery and the hydrographical conditions refers exclusively to data from the investigations in the Gullmar Fjord. In order to find out, however, whether these conditions hold as regards fishing and hydrography were typical over a wider area a comparison can be made between the hydrography and the fishery in Dynekilen (Fig. 17) in February 1943 and the same factors in the Gullmar Fjord.

A comparison between Figs. 15 and 17 shows that the hydrographic conditions within the fjord areas are, in the main, similar. Certain differences, however, in the times of the culmination of the inflow of the bottom water can be found. Generally, however, it may be said that the flow to the fjords of, for instance, the saltier water layers, is to some extent coincident.

From Table 11 it will be seen that the fishery at Dynekilen (and Säcken) only began on the 1st of February and continued very intensively for many days. Simultaneously a strong water wave — though of short duration — of salt bottom water arrived at Dynekilen and culminated on the 1st. The catch figures comprise both those from Säcken and from Dynekilen, and therefore the maximum of the fishery does not always coincide with the maximum of the bottom wave. The great fishing later on at Dynekilen, between February 22nd—26th, occurred at the same time as the influx of a new saltier bottom wave into the fjord. Also, in this case the fishery in Säcken must have preceded that at Dynekilen, and thus the joint catch figures from Säcken and Dynekilen do not always show the exact

a between the fishery at Dynekilen and the of salt bottom water. But there is also at len an obvious relation between fishery and raphy. The migration to the Strömstad wa- February 1943 took place — as will be seen Tab. 10 — in stages, and the sprat did evi- not reach Dynekilen — lying well up in the — much before the middle of the month, though an earlier wave of salt water had the fjord about the 8th of February.

Summarizing from the above material our ex- es regarding the correlation between the fishery and the hydrographical conditions in ords under review the following might be

The meteorological and hydrographical con- during the months under observation were sufficiently extreme nor different to other hat they alone could have caused the extra- ry fishery within the skerries.

The comparatively mild winters with very e weather and changing direction of winds ly created a hydrographical situation of ac- ter exchange in the fjords, preparing there- conditions for an immigration of sprat.

It is also obvious that the entrance of the nto the fjords occurred in close correlation ydrographical changes, chiefly the inflow of ttom water ($30-33\text{ ‰}$).

The conditions for a sprat fishery seem to sent especially when the isohalines show a

steep fall which means that the salt water which suits the sprat best is then entering the fjords.

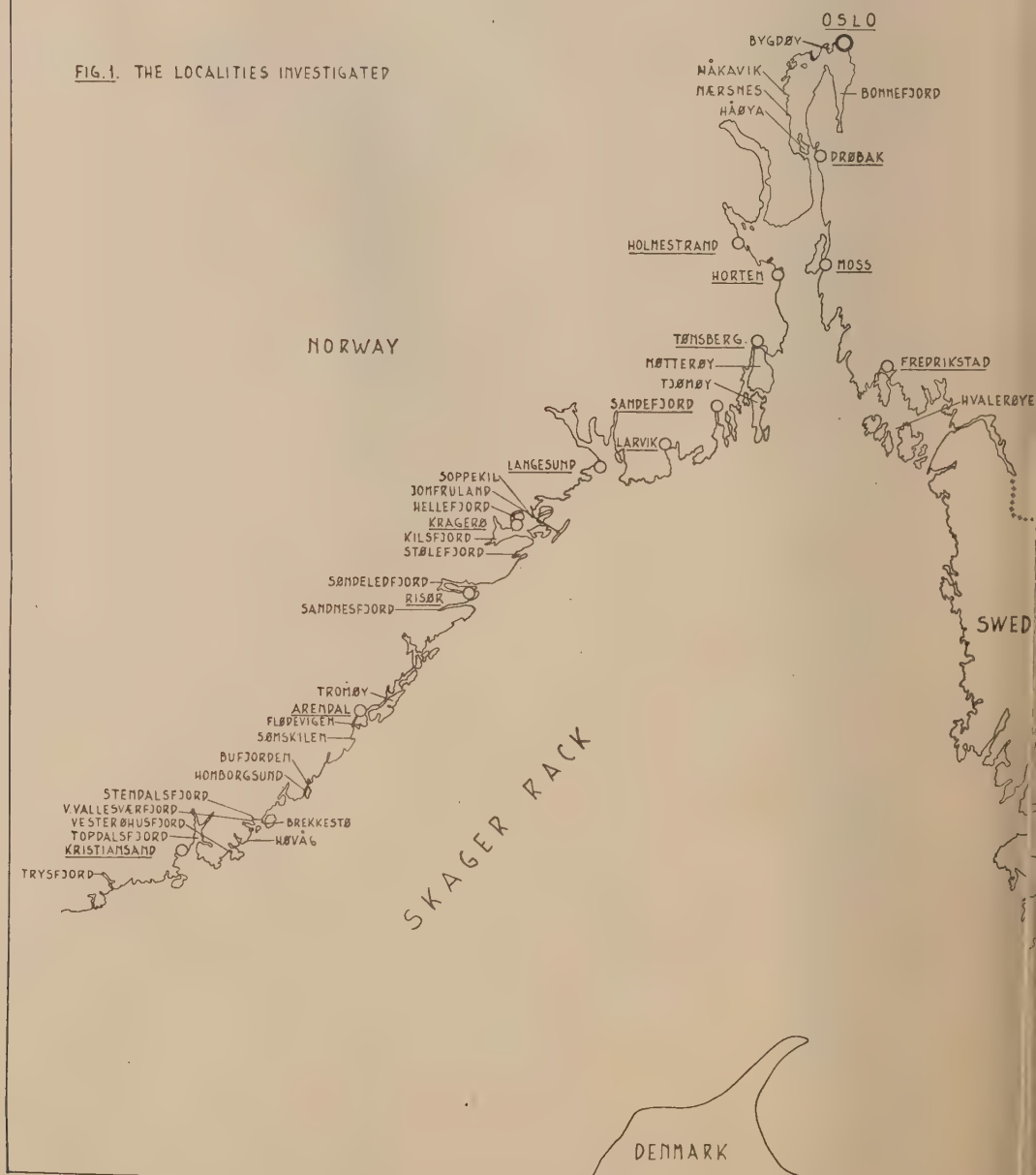
5. This fishery can even be continued while the salt water layers are being driven out of the fjord, but it takes place chiefly in the outer parts of the fjord and during the emigration of the sprat.

6. Even if the hydrographical conditions during the winter of 1942 were favourable to an immigration of sprat to the fjords, the chief cause of the great accumulation of sprat must have been the biological peculiarities characterizing those stocks that had grown up during the cold winters (1940—42).

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FIG. 1. THE LOCALITIES INVESTIGATED



Appendix.

The Number of Vertebrae and Rays of the second dorsal Fin
of Fishes from the Norwegian Skagerak Coast.

By

Alf Dannevig.

I. Introduction.

In the present paper the results are given of counts of vertebrae and finrays of some species from the Norwegian Skagerak coast, and the variations are stated.

The discussion on the problem of the causes will, however, be postponed until sufficient experimental material is at hand. From the literature on this problem the following short extracts will be of interest.

Johns. Schmidt (1919) has demonstrated that the number of vertebrae of the parents influences the number of vertebrae of the brood. He has, however, also demonstrated that the variation in the number of vertebrae can be altered by external factors (temperature) during the early stages of development (1921). The same result is arrived at by Mottley (1933) and Tåning (1944) working with the trout.

By samples from nature Schmidt (1930) has demonstrated that the number of vertebrae of the cod diminishes as we proceed from north to south, on both sides of the Atlantic, the temperature apparently being the regulating factor. The number of vertebrae also diminishes from ocean to fjord, — and into the fjords, the distance from the surface or the depth probably being of importance. It may be that the varying salinity here is of importance.

By our investigations (Dannevig 1932) it was found that the number of vertebrae of the cod in the salt water pond at Flödevigen in the fjord was extremely low — 50.48 (the urostyle included) — against 52.12 out at sea. It was suggested that the low number of vertebrae in the cod was the result of the relatively high temperature to which the larvae had been exposed. In his paper (Dannevig 1933) it is demonstrated that the number of vertebrae of the coalfish increases as we pass from the eastern to the western part of the Norwegian Skagerak coast, and that the number of vertebrae varies with the distance of the individuals of the same brood — the larger individuals having a larger number of vertebrae than the medium and smaller ones.

In the case of *Gobius flavescens*, Fabr. Johnsen (1936) has found the same correlation between size of fish and number of vertebrae.

Ruud (1939) has dealt with the number of vertebrae of the Oslofjord cod, and found some divergences between the population of the inner and outer fjord.

Runnström (1941) has shown that the number of vertebrae of the "Vårsild" is higher than the number of vertebrae of the "Storsild". He suggests that the difference in number of vertebrae is caused by the difference in temperature, — the Storsild spawns in warmer water than the Vårsild.

By experiments on trout it has been shown (Dannevig 1936 and 1941) that large eggs of one female give larvae with a higher number of vertebrae than the medium and smaller ones from the same individual.

The North Sea herring has a lower number of vertebrae than the Norwegian spring herring. Schnakenbeck (1936) has observed that the eggs of the former are smaller than those of the latter mentioned.

In the case of spring-spawners in the sea the size of the eggs diminishes as the season advances. It may therefore be suggested that eggs spawned early in the season will yield fish with a higher number of vertebrae than the eggs spawned later in the season. It may be that the size of the eggs is a primary factor.

It has been shown by several investigators that the number of vertebrae in one locality may vary from one year-class to another. In the material dealt with in this paper it also appears that the number of vertebrae of the same brood in one locality varies from time to time. See also Schmidt (1930). We have, therefore, also taken into consideration the different age-groups of the same brood. When dealing with the quite young fish in the littoral region, it is of special importance to study the young before the low winter temperature may have had a chance to influence the composition of the population, — some individuals being more sensitive to low temperature.

Table I. Oslofjord

		July 1938		Oct. 1938		Σa -group		
		<i>n</i>	$\bar{v}$	<i>n</i>	$\bar{v}$	<i>n</i>	$\bar{v}$	
I	Bonnefjord	206	51.88	112	52.04	—	—	62
II	Bygdøy—Håkavik	340	51.93	309	51.99	—	—	322
III	Nærnes—Håøya	—	—	97	51.90	—	—	181
	The inner Oslofjord	546	51.91	518	51.98	1064	51.95	563
	σ	—	0.80	—	0.78	—	0.788	—
	ε	—	0.034	—	0.034	—	0.02416	—
IV	Near Drøbak	188	52.08	463	52.00	—	—	223
V	Near Holmestrand	171	52.05	700	52.02	—	—	151
VI	Vrengen—Tjømø	169	51.93	252	51.96	—	—	103
VII	Hvalerøyene	270	51.98	148	51.99	—	—	—
	The outer Oslofjord	798	52.01	1563	52.00	2361	52.00	477
	σ	—	0.76	—	0.80	—	0.773	—
	ε	—	0.027	—	0.020	—	0.01592	—
	The Oslofjord, total	—	—	—	—	3425	51.98	—

tures than others. We have therefore not utilized the ordinary grouping in 0, I, II, etc. age-groups, but instead grouped the fish as to the calendar year. The (*a*) group being those hatched in the same calendar year and so on.

As to the methods used it may be mentioned that the vertebrae have been counted on unstained specimens, the flesh on one side being removed. The method of cooking the fish was troublesome when dealing with a high number of very small ones. When fused vertebrae, or conspicuous anomalies were observed, the specimens were discarded. The percentage of such individuals was, however, quite insignificant in the material dealt with. The urostyle is counted as one vertebra.

Statistically the material has been dealt with by Gunnar Aarstøl and K. J. Christensen. For the terms used see Gunnar Jahn: "Statistikkens teknikk og metode" Oslo 1930:

The Standard error: $\sigma = \sqrt{s^2 - Z^2}$

The Standard error of the mean: $\varepsilon = \frac{\sigma}{\sqrt{n}}$

The Standard error of the difference *d* (between two means M_1 and M_2): $= \frac{M_1 - M_2}{\sqrt{\varepsilon_1^2 + \varepsilon_2^2}}$

II. Vertebrae and Rays of the second dorsal Fin of the Cod (*Gadus callarias* L.).

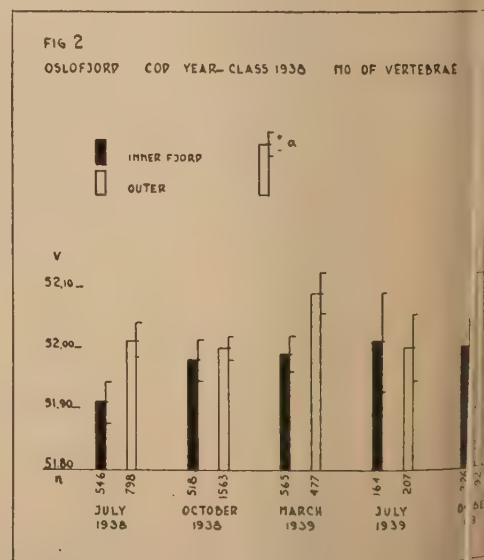
A. The young Fish from the littoral Region.

The young fish dealt with is caught in the littoral region by a fine-meshed seine. The 1938 year-class was very numerous in the Oslofjord, and also on the eastern and middle reaches of the Norwegian Skagerak coast. This year-class is also best

represented in our countings, and we will consider this material first.

The material from the Oslofjord is contained in Tab. I. The different localities are arranged from the bottom of the fjord towards the Skagerrak. The districts from the Bonnefjord to Håøya are treated as the inner fjord, the district Drøbak is included in the outer fjord.

The Bonnefjord is comparatively deep, and the littoral region is narrow. The district Bygdøy—Håkavik has comparatively large areas of shallow water. The district Nærnes—Håøya has a narrow littoral region. This is still more the case at



ss 1938. No. of Vertebrae.

1939	Oct. 1939		Σ -b-group		Σ		
v	n	v	n	v	n	v	
52.20	59	51.80	—	—	494	51.95	I Bonnefjord
51.92	115	52.03	—	—	1195	51.97	II Bygdøy—Håkavik
—	52	52.15	—	—	330	51.99	III Nærsnes—Håøya
52.01	226	52.00	955	52.00	2019	—	The inner Oslofjord
0.98	—	0.78	—	0.80	—	—	σ
0.083	—	0.052	—	0.026	—	—	ε
52.07	21	52.14	—	—	936	52.06	IV Near Drøbak
52.05	119	52.06	—	—	1274	52.03	V Near Holmestrand
—	19	52.26	—	—	543	51.99	VI Vrengen—Tjømø
51.70	33	52.27	—	—	484	51.98	VII Hvalerøyene
52.00	192	52.12	876	52.08	3237	—	The outer Oslofjord
0.79	—	0.78	—	0.774	—	—	σ
0.055	—	0.056	—	0.026	—	—	ε
—	—	—	1831	52.04	5256	—	The Oslofjord, total

In the outer Oslofjord there are great stretches of deep water, but the areas fished at Holmestrand, Vrengen—Tjømø and Hvalerøy, are shall-

low. It will be seen that we have taken fairly large samples during the two years 1938 and 1939, (3425 and 1831 specimens respectively).

The Fig. 2 gives the total result. It will be seen that the number of vertebrae varies about 52 v .

As to the number of vertebrae in the inner fjord, it is only 51.91 in July 1938. In October 1938 we find 51.98 in the same district. The difference between July and October, 0.07 v , is not great enough to ensure any degree of significance, — the difference 0.07 is only 1.45 ε (d).

Passing to the outer part of the fjord the number of vertebrae of March and October 1939 are conspicuously high. The difference between October 1938 and March 1939 is 0.09 = 2.26 ε (d).

At the top of Fig. 3 are given the values for each district in July 1938. The number of vertebrae rises from the inner fjord to Drøbak, after which it once more decreases. The values are also given for the total number of specimens taken in 1938—1939. The tendency found in July 1938 still holds good. In the same figure is also given (from Löversen: "Fiskeyngelens forekomst i strandregionen", in manuscript) the number of young caught per haul in July 1938. In his paper Löversen has suggested that we had in 1938 quite an exceptionally heavy brood, the centre of which was situated near the entrance to the Oslofjord. From there the number diminished towards the inner Oslofjord and towards the west along the Skagerak coast.

From Ruud (1939) — see Tab. II and Fig. 5 — it is obvious that the number of vertebrae in the inner Oslofjord normally is less than 52 v . The average of the material at hand for 1934 to 1937 is 51.90. It is, therefore, reasonable to assume that the low number in the inner fjord in 1938 refers to the local stock.

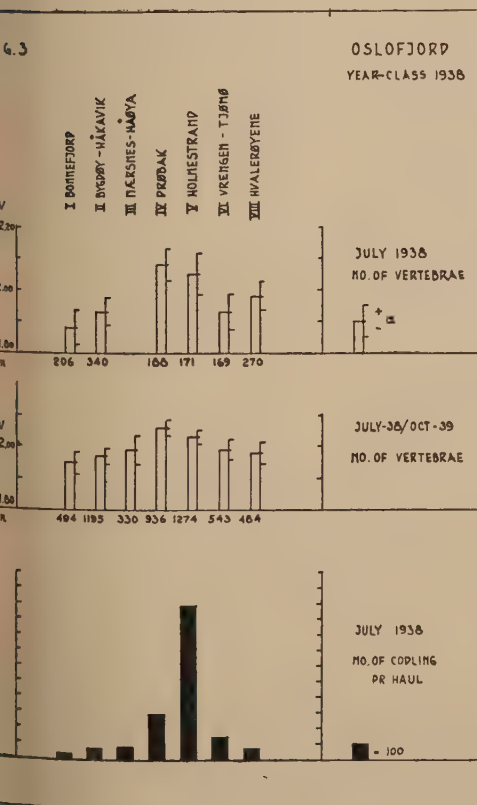


Table 1.
1939. May 3-6. The Occurrence and Length
of the Pelagic Cod Fry.

The stations are arranged from the inner part of the Oslofjord towards the Skagerak (Dannevig 1945).

Stations: L. mm.	74	75	76	73	70	69	68	67	66	Total
3	—	5	1	1	—	—	—	—	—	7
4	5	9	5	—	—	—	—	—	1	20
5	7	1	4	—	—	—	—	—	—	12
6	5	6	1	—	—	—	—	—	—	12
7	1	2	—	—	—	—	—	1	—	4
8	1	2	—	—	—	—	—	—	—	3
9	—	—	—	—	—	—	—	1	—	1
10	—	—	—	—	—	—	—	1	—	1
11	—	—	—	—	—	—	—	2	3	5
12	—	—	—	—	—	2	3	8	2	15
13	—	—	—	—	—	—	8	5	1	14
14	—	—	—	—	—	2	8	12	1	23
15	—	—	—	—	—	—	1	18	—	19
16	—	—	—	—	—	—	2	7	2	11
17	—	—	—	—	—	—	1	7	1	9
18	—	—	—	1	1	1	2	13	3	21
19	—	—	—	—	2	3	2	4	2	13
20	—	—	2	2	—	1	2	3	4	14
21	—	—	—	—	1	1	—	—	—	2
22	—	—	1	—	—	1	—	2	—	4
23	—	—	—	—	2	—	—	—	—	2
24	—	—	1	—	—	1	2	—	1	5
25	—	—	1	—	—	1	2	—	—	4
26	—	—	—	—	—	—	—	—	1	1
27	—	—	—	—	—	—	2	1	—	3
28	—	—	—	—	—	—	2	—	—	2
29	—	—	—	1	—	—	—	—	—	1
30	—	—	1	—	—	—	—	—	—	1
31	—	—	—	—	1	—	—	—	—	1
32	—	—	—	—	—	—	—	1	—	1
33	—	—	—	1	—	—	—	—	—	1
34	—	—	—	—	—	1	—	—	—	1
35	—	—	—	—	—	—	1	—	—	1
Total	19	25	17	6	7	14	38	86	22	234

In fishing for pelagic eggs and larvae in the spring, it turned out that the Bonnefjord this year had a good stock of pelagic larvae, the size of which, however, differed widely from the larvae of the outer fjord. Whether the larvae of the Bonnefjord are the result of local spawning, or derive from the 100 millions of cod fry liberated that year from the Flødevig Seafish Hatchery, cannot be ascertained on the basis of the material at hand.

The rising number of vertebrae in the inner fjord may be ascribed to an influx in the littoral region of young cod from deeper waters or from the district near Drøbak. In his paper Löver-

sen mentions that it is likely that such an influx has occurred. The number of specimens per haul in the Bonnefjord keeps on the same level in March 1939, contrary to what is normally expected.

Table 2.
Number of Cod (Year-class 1935) per Haul
in the Littoral Region of the Oslofjord.
Number of hauls shown in brackets (From Löversen)

	Inner fjord	Outer fjord
July 1938	61.0 (27)	366.9 (29)
Oct. 1938	55.0 (26)	131.0 (34)
March 1939	60.5 (12)	91.0 (9)
July 1939	13.2 (16)	11.5 (22)
Oct. 1939	9.1 (23)	7.3 (33)

As to the high number of vertebrae in May and October 1939 in the outer fjord, it is reasonable to assume that this is occasioned by an invasion into the littoral region by young cod from deeper waters. That such an invasion normally occurs in autumn and spring is well known. Cod again leaves the littoral region when the water turns warm during summer.

The variation in growth of young cod is very great, and the quickest growing individuals will first come into contact with the fishing gear. In the inner Oslofjord this occurs when the fish are about one year old. As mentioned in the previous section it has been found on several occasions that the largest individuals of one brood have a higher number of vertebrae than the smaller. In some instances this was also found in the case of cod from the

Table II. Average Number of Vertebrae
in the Oslofjord inside and outside
Drøbak respectively.
Number of Cod investigated in brackets.

Year-Class	Age-Groups	Inside	Outside
1934	c	51.24 (17)	52.08 (13)
	d	51.61 (28)	—
	e	51.43 (7)	—
1935	b	52.02 (182)	51.90 (307)
	c	51.86 (75)	52.16 (96)
	d	52.08 (60)	—
1936	a	—	51.62 (225)
	b	51.83 (204)	51.65 (111)
	c	51.83 (171)	—
1937	a	—	52.23 (57)
	b	52.50 (10)	52.33 (3)
1938	a	51.95 (1064)	52.00 (236)
	b	52.00 (955)	52.08 (876)
1939	a	51.80 (5)	52.11 (27)

jord by Ruud. It was then to be expected the number of vertebrae would diminish as the age went on. This was not the case. We there-computed the average number of vertebrae in the small, medium, and large individuals from each locality, and the results showed (see Tab. 3, which gives the totals) that the theory that the number of vertebrae increased with the greater size of the fish did not apparently hold good in this case.

The values for Dröbak and Holmestrand were computed gradually according to size. In all districts of Vrengen—Tjömö, the smallest individuals had fewer vertebrae than the average of fish from other groups. The same results were seen when comparing the average of the small and medium with the largest. The highest correlation is found at Dröbak. It may be that the material here is most homogeneous.

Turning now to the 1938-group on the Skagerak coast (Tab. III, the number of vertebrae of the cod in the first summer and autumn is higher than that in the inner and outer Oslofjord.

	Age-Group	$\bar{v} =$	$\bar{\epsilon} =$
Oslofjord	1938	51.95	0.02416
Oslofjord	1938	52.00	0.01592
Skagerak Coast	1938	52.05	0.01647

The difference between the inner and outer Oslofjord is significant. (The difference $d = 0.10 = 3.42 \epsilon$ (d). Between the inner and outer Oslofjord the difference $d = 0.05 = 1.64 \epsilon$ (d).)

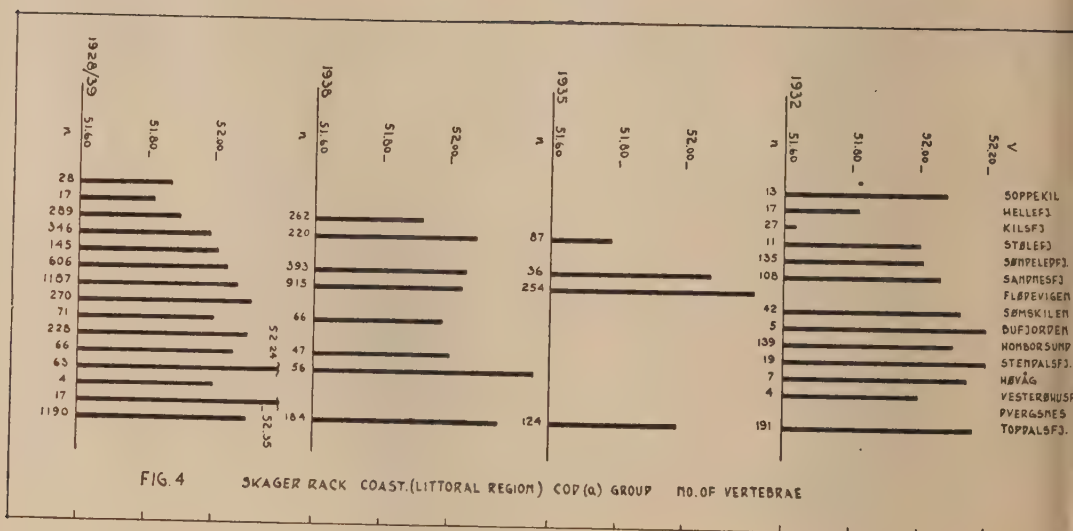
Table 3.
Oslofjord 1938–39. Cod. Year-class 1938.
Average Number of Vertebrae according to Size.
Number examined in (—).

Locality	Small	Medium	Large	Total
Bonnefjord	51.82 (163)	52.02 (163)	52.01 (163)	51.95 (494)
Bygdøy—Håkavik	51.96 (441)	51.95 (414)	52.01 (340)	51.97 (1195)
Nærnes—Håøya	51.90 (99)	52.04 (112)	52.01 (119)	51.99 (330)
Near Dröbak	51.98 (313)	52.08 (307)	52.11 (316)	52.06 (936)
Near Holmestrand	52.01 (418)	52.03 (437)	52.06 (419)	52.03 (1274)
Vrengen—Tjömö	52.01 (184)	51.98 (185)	51.98 (174)	51.99 (543)
Hvalerøyene	51.91 (160)	52.04 (157)	52.00 (167)	51.98 (484)

The details in Fig. 4 (1938) and in Tab. III show that the isolated Kilsfjord has a low number, 51.92, and the skjærgård-district in the western part of the Skagerak coast has a very high number — 52.25. The variation on the Skagerak coast may be explained in the same way as in the Oslofjord. The Kilsfjord and the Skjærgård has apparently a population of its own, the one with a low number, the other with a high number of vertebrae.

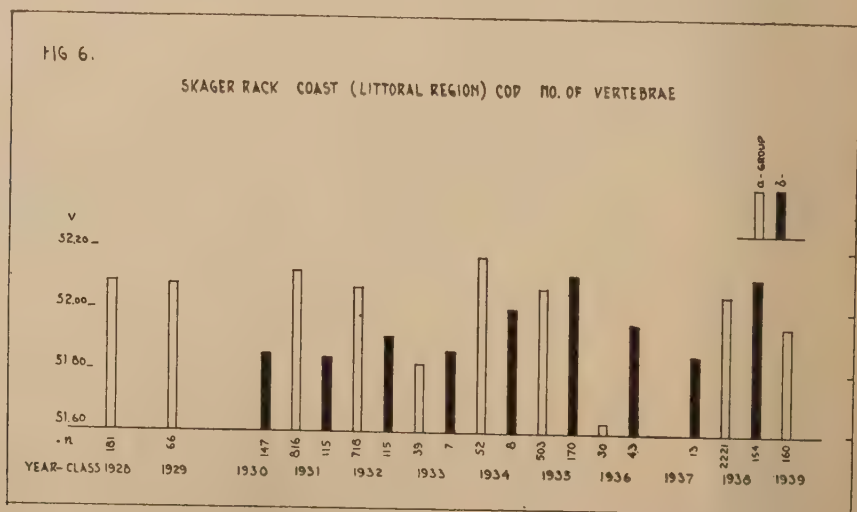
Table III. Cod. Littoral Region of the Skagerak Coast.
Average Vertebrae from various Localities —
arranged from the East to the West.

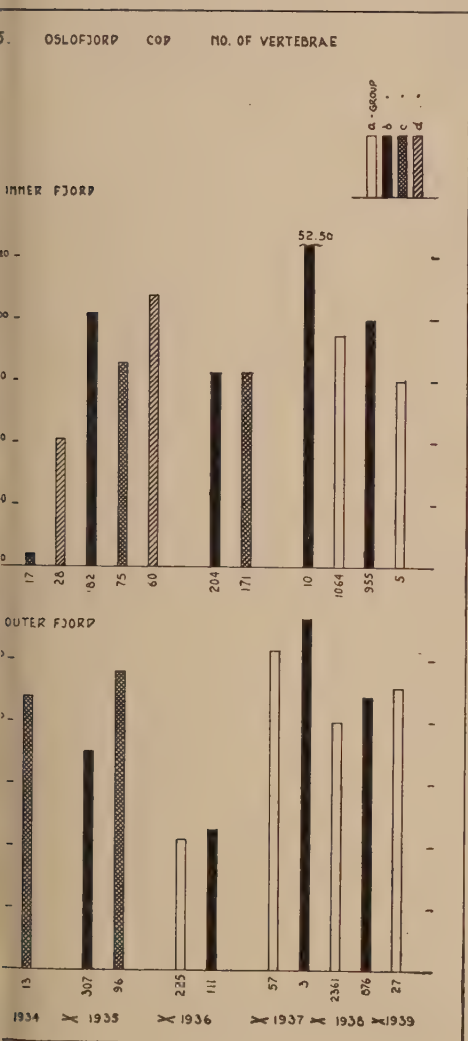
Locality	Year-Class	1928–1939 (1938 excluded)		1938	
	Age-Group	a	b	a	b
Soppekil		52.04 (28)	51.66 (9)	—	52.00 (23)
Hellefjord		51.82 (17)	52.13 (48)	—	—
Kilsfjord		51.63 (27)	51.75 (12)	51.92 (262)	—
Stølefjord		51.84 (126)	51.50 (6)	52.08 (220)	53.50 (2)
Sønedeledfjord		52.00 (145)	51.65 (117)	—	52.06 (31)
Sandnesfjord		52.02 (213)	51.88 (17)	52.05 (393)	52.10 (20)
Flødevigen		52.13 (453)	52.05 (142)	52.04 (915)	52.12 (78)
Sømiskilen		52.11 (270)	52.00 (183)	—	—
Bufjorden		52.20 (5)	—	51.98 (66)	—
Homborsund—Brekkestø		52.10 (228)	51.88 (34)	—	—
Stendalsfjord & V. Vallesværffjord		52.20 (19)	52.20 (5)	52.00 (47)	—
Høvåg		52.14 (7)	52.50 (2)	52.25 (56)	—
Vesterøhusfjord		52.00 (4)	52.17 (6)	—	—
Dvergsnes		52.35 (17)	52.00 (1)	—	—
Topdalsfjord		52.09 (1006)	52.00 (114)	52.15 (184)	—
		52.07 (2565)	51.92 (696)	52.05 (2143)	52.11 (154)



Turning now to the other year-classes we have in Fig. 5 and Tab. II the totals for the Oslofjord. The material up to 1937 has previously been dealt with by Prof. Ruud in the paper mentioned above. The figure indicates that the number of vertebrae varies widely, — the number of specimens, however, being rather small for all years except 1938. In some of the years we have material from the inner as well as from the outer fjord from the same year-classes. Taking the mean values for those years, 1938 excluded, we have in the inner fjord 493 specimens with a mean number of vertebrae of 51.90. In the outer part of the fjord we have 557 individuals with 51.91 *v*. The material

is, however, not very homogeneous. By counting the larger samples Ruud has shown that it is reasonable to assume that the cod in the inner and outer Oslofjord in some cases may have a different number of vertebrae. It is of interest to note that the number of vertebrae is lower than for the 1938 year-class. As to the great variations in the inner fjord, this may, as mentioned by Ruud, in one instance be due to fish brought into the fjord from other localities (fish caught in 1938). The values from the outer fjord for the year-classes 1936 are exceedingly low. The material is, however, secured from the very shallow waters of Holmestrand.





to the Skagerak coast, Fig. 4, besides giving ults for 1938, also gives the values for the nt fjords in 1932 and 1935. The number ed is low in most of the fjords. The totals 1939, Tab. III, demonstrate a tendency to there being a higher number of vertebrae western district.

.6 gives the number of vertebrae for the nt broods. Those being fairly well repre- all have more than 52.06 *v*, except 1938, has 52.05 *v*. This refers to the (*a*)group. umber of vertebrae in the (*b*)group varies n the littoral region, Tab. III. This is prob- iefly due to the material being collected in nt seasons. The (*b*)group 1930 was caught

in midsummer, the greatest sample of the (*b*)group 1938 was caught in February. The first mentioned had a low, the last mentioned a high number of vertebrae. The material is not great enough, however, to discuss this problem, and the different districts are not equally well represented to warrant much attention being paid to the means of Tab. III.

B. The grown-up Cod.

The grown-up cod is partly secured by experimental fishing with traps at a depth of approximately 15 metres at Flødevigen, and partly bought in the market. In the former, the vertebrae have not been counted, the number in each season being small. The number of rays in the second dorsal fin, however, have been ascertained. We have the best samples of vertebrae-countings from the spawners used at the hatchery.

In Tab. IV and Fig. 7 are given the results of the countings of vertebrae of the spawning cod. The cod is bought in the market, and most of it is caught in the neighbourhood of Arendal. In some cases, however, the material may come from the small fjords, and in other cases from districts farther away. The number of vertebrae varies to a small degree between 51.83 and 52.00. None of the differences being larger than $2\varepsilon(d)$, we cannot be sure that they are significant. It is evident, however, that the number of vertebrae of the grown-up cod is somewhat lower than that found in the *a* group in this district but corresponds to that of the *b* group. When buying specimens in the market, care is taken to select those with the highest vitality. Those are the ones fished in shallow water. In this way an artificial selection is apt to take place, which naturally will affect the number of vertebrae in the way found. (see Schmidt 1930).

The number of vertebrae is relatively low for the year-classes 1925—1928 inclusive. The value for 1935 may not be representative, as the specimens examined are few, and they represent only those with the greater growth-rate of their brood.

About New-Year 1937 some samples from different places were secured, and the number of vertebrae was counted. Number in (—).

Table 4.

Locality	Year-Class	
	1934	1935
Hvalerøyene	—	52.16 (96)
Skagerak outside Kragerø	—	52.14 (98)
The fjords near Kragerø	51.00 (1)	51.83 (96)
Boknfjord (W. Norw.)	52.08 (13)	52.13 (83)
Namdalen (Nordland)	52.08 (93)	51.70 (7)

The material from the year-class 1934 is very scanty. The number of vertebrae of fish from Namdalen is relatively high, as might be expected.

Table IV. Cod. Spawners from the Hatchery.

Year-Class No. of Vertebrae	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	
48	—	—	—	—	—	1	—	—	—	—	—	1
49	—	—	—	1	—	1	—	—	1	1	—	4
50	5	2	3	23	12	11	11	11	7	5	3	7
51	36	17	49	113	81	98	128	75	63	50	15	172
52	78	32	103	260	228	278	263	205	139	113	30	172
53	22	10	34	83	88	108	103	78	58	55	15	61
54	—	1	1	6	8	1	8	6	2	—	2	5
55	—	—	—	1	—	—	—	—	—	—	—	1
<i>n</i>	141	62	190	487	417	498	513	375	270	224	65 ¹⁾	322
<i>M</i>	51.83	51.85	51.90	51.89	52.00	51.97	51.94	51.98	51.93	51.96	51.97	51.4
σ	0.72	0.78	0.71	0.80	0.77	0.73	0.77	0.77	0.78	0.77	0.88	—
ε	0.061	0.099	0.052	0.037	0.038	0.033	0.034	0.040	0.048	0.052	0.111	—

1) The year-class 1935 includes only the largest specimens.

As to the 1935 year-class the number of vertebrae in the fjords near Kragerö is distinctly lower than some miles outside the same coast, — the difference being $0.31 \nu = 3.1 \varepsilon (d)$. In the Boknfjord we find the same values as in the Skagerak. The cod from the Hvalerøyene have a remarkably high number of vertebrae indicating that we here have to deal with fish of the Skagerak type.

For the spawners the rays of the second dorsal fin were counted, and the results are given in Tab. V and Fig. 7. The average for 3214 individuals is 18.36. The variation in the number of rays is great. The last value for 1935, however, is not representative.

The figure indicates that there is no correlation between the number of vertebrae and number of rays.

Since 1921 we have been undertaking some experimental fishing with traps near Flødevigen. As

we have been fishing all the year in the same places, and with the same gear, the catches (*n*) given on Fig. 7 B may give an indication as to the strength of the different year-classes. The number of rays have been counted from 1930, and the values for each year-class are given in Tab. VI and Fig. 7. The variations are great, and for the period comparable, they practically conform to the variations found in the rays of spawners. We here, as in the spawners, find rising numbers from 1928 to 1932. It is worth noting that the richest year-classes 1928, 1938, and 1941, have the lowest number of rays. The values of the poor year-classes vary. The average for 2081 individuals is 18.29 against 18.36 by the spawners.

At the bottom of Fig. 7 is given the average temperature of the sea water from April 1. to June 30. at a depth of approximately 15 metres. It is difficult to find any correlation between these

Table V. Cod. Spawners from the Hatchery.

Year-Class No. of Rays	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	
14	—	—	—	—	1	—	—	—	—	—	—	—	2
15	—	5	—	1	3	2	4	—	1	4	4	2	13
16	4	17	2	8	18	20	20	18	5	8	7	3	61
17	17	56	16	34	94	81	87	80	50	49	38	10	90
18	24	99	26	50	144	108	131	155	102	87	66	27	38
19	15	97	21	49	115	103	132	132	105	65	63	9	11
20	10	46	9	33	41	30	55	54	50	26	23	5	—
21	2	14	3	5	10	9	19	16	17	12	5	1	—
22	—	3	1	1	5	4	1	6	2	2	—	—	—
<i>n</i>	72	337	78	181	431	357	449	461	332	253	206	57 ¹⁾	21
<i>M</i>	18.22	18.41	18.41	18.45	18.24	18.22	18.37	18.45	18.61	18.23	18.29	18.00	3.8
σ	1.19	1.30	1.19	1.25	1.21	1.15	1.23	1.18	1.27	1.25	1.18	1.16	—
ε	0.141	0.071	0.135	0.093	0.058	0.061	0.058	0.055	0.070	0.079	0.083	0.15	—

1) The year-class 1935 includes only the largest specimens.

YEAR-CLASS 1925

1930

1935

1940

FIG. 7

A. SPAWNERS FROM THE HATCHERY

NO OF VERTEBRAE

V

32.00
31.90
31.80
31.70

n

141 62 190 487 417 497 513 375 270 224 [65]

a

NO. OF RAYS OF 2. DORSAL FIN

R

18.60
18.40
18.20
18.00
17.80

n

72 337 78 181 431 357 449 461 332 253 206 [57]

THE MATERIAL FOR 1935
REPRESENTS ONLY THE
LARGEST SPECIMENS
OF THAT YEAR-CLASS

B. COF CAUGHT IN TRAPS AT FLØDEVIGEN

NO. OF RAYS OF 2. DORSAL FIN

R

18.60
18.40
18.20
18.00
17.80

n

139 127 81 89 132 129 105 105 66 97 321 44 196 250 124 68

C. MEAN TEMPERATURE C° APRIL-JUNE AT 15 M. AT FLØDEVIGEN

C°

8
7
6
5

YEAR

1925

1930

1935

1940

Year-Class	1933	1934	1935	1936	1937	1938	1939	1940
<i>Skagerak Coast:</i>								
Soppekil	—	—	—	54.76 (92)	—	—	—	54.76 (92)
Hellefjord	—	—	—	54.67 (82)	—	—	—	54.67 (82)
Kilsfjord	54.86 (111)	—	54.83 (253)	54.66 (189)	—	54.77 (177)	—	54.78 (730)
Søndeledfjord	54.39 (389)	—	54.94 (241)	54.74 (141)	—	—	—	54.65 (901)
Sandnesfjord	54.68 (286)	54.82 (130)	54.80 (153)	—	—	54.83 (139)	54.80 (117)	54.78 (953)
Flødevigen	—	54.84 (258)	55.00 (77)	54.45 (75)	—	54.74 (450)	—	54.75 (962)
Topdalsfjord	—	54.78 (360)	54.95 (220)	—	—	—	—	54.90 (342)
Trysfjord	54.70 (111)	—	—	—	—	—	—	54.70 (111)
Σ	54.68 (897)	54.81 (870)	54.90 (944)	54.67 (579)	54.76 (766)	54.80 (117)	—	54.75 (4173)
<i>The Oslofjord:</i>								
I Bonnefjord	—	—	—	—	—	54.68 (173)	—	—
II Bygdøy—Håkavik	—	—	—	—	—	54.64 (151)	—	—
IV Near Drøbak	—	—	—	54.67 (63)	—	54.84 (95)	54.53 (170)	—
V Near Holmestrand	—	—	—	—	—	54.96 (56)	—	—
VII Hvalerøyene	—	—	—	54.70 (157)	—	—	—	—
Inner Oslofjord	—	—	—	—	—	54.66 (324)	—	—
Outer Oslofjord	—	—	—	54.69 (220)	54.89 (151)	54.53 (170)	—	—

Table VIII. Pollack. No. of Vertebrae.

Samples < 10 Specimens not included.

Year-Class	1930	1931	1932	1935	1936	1938
Age-Group	<i>b</i>	<i>c</i>	<i>b</i>	<i>a</i>	<i>a</i>	<i>a</i>
<i>Skagerak Coast:</i>						
Risør skjærgård	—	—	—	—	53.27 (83)	53.24 (58)
Sandnesfjord	—	—	—	—	53.24 (66)	53.52 (176)
Flødevigen	52.79 (77)	52.74 (207)	53.13 (603)	—	52.82 (28)	53.59 (76)
Topdalsfjord	—	—	—	—	—	53.52 (56)
Torvefjord	—	—	—	53.20 (122)	—	53.42 (146)
Σ	52.79 (77)	52.74 (207)	53.13 (603)	53.20 (122)	53.19 (177)	53.27 (123)
<i>Oslofjord, July:</i>						
I Bonnefjord	—	—	—	—	—	—
II Bygdøy—Håkavik	—	—	—	—	—	—
IV Near Drøbak	—	—	—	—	—	—
VI Vrengen—Tjømø	—	—	—	—	—	—
VII Hvalerøyene	—	—	—	—	—	—
<i>Oslofjord, October:</i>						
IV Near Drøbak	—	—	—	—	—	—

temperature and the number of vertebrae or rays. The character of the season is apparently of no consequence for the formation of vertebrae and rays. But as the time of spawning varies from year to year, nothing can be said as to the actual problem of the influence of temperature in the critical stages.

The material from other localities is somewhat scanty, and will be dealt with on another occasion. The samples of young fish bought in the market about New-Year 1937 had the following number of rays:

Table 5.

Locality	Year-Class	
	1934	1935
Hvalerøyene	—	18-32 (96)
Skagerak outside Kragerø	—	18-46 (91)
The fjords near Kragerø	—	18-46 (94)
Boknfjord	17-80 (10)	18-39 (83)
Namdalen (Nordland)	17-42 (85)	17-14 (7)

Contrary to what was found in the case of vertebrae, the cod from the Skagerak outside Kragerø, and those from the fjords, have the same number of rays. The number of rays at Namdalen is very low.

It is evident that the variations in the number of vertebrae and the number of rays are not parallel phenomena. In order to have a good basis to discuss the differences of the population in different districts, it will, therefore, be of importance to take into account both the number of vertebrae and the number of rays.

III. Whiting (*Gadus merlangus* L.).

Tab. VII and Fig. 8 give the totals of our vertebrae-countings — all being from fish in the (a) group. The material is not very great and somewhat heterogeneous.

In the Oslofjord the number of fish caught is moderate, rich catches being made in July 1938 in the Bonnefjord, and at Drøbak in July 1939 (L. Översen in manuscript). From the inner part of the fjord we have two samples, both in 1938, giving a number of vertebrae 54-68 and 54-64. In the outer fjord the values simultaneously in two samples were 54-84 and 54-96 — the last in the district of Holmestrand. The totals for the inner fjord were 54-66, and for the outer fjord 54-89. This difference is significant, $d=0.23=3\epsilon(d)$. In the outer fjord we have the following values for the year-classes 1937, 1938, and 1939: 54-69, 54-89, and 54-53, — the values for 1938 being the highest. For 1937 and 1939 the values correspond to those found in the inner fjord in 1938.

The number of vertebrae from the Skagerak coast, all year-classes and localities included, is 54-75. The values for 1933 and 1937 are relative-

ly low. The values for 1934 and 1935 are relatively high. The number of vertebrae in 1934 was intermediate = 54-76. As the material is collected from the same localities each year, it is not convenient to pay too much attention to the values for each district. It is evident, however, that in the material at hand there is no real increase from the eastern to the western part of the Skagerak coast.

The values for 1938 for the Skagerak coast are intermediate to those found for the inner and outer Oslofjord for the same year.

The correlation between the number of vertebrae and size of individuals is illustrated in Fig. 6, giving the results of the countings of the large samples.

Table 6. Number of Vertebrae.

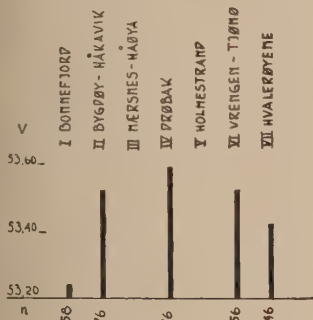
	n	Small	Medium	Large
1933 Söndeledfjord	398	54-22	54-44	54-55
1933 Sandnesfjord	268	54-42	54-67	54-88
1934 Söndeledfjord	130	54-84	54-77	54-88
1934 Sandnesfjord	258	54-81	54-92	54-88
1934 Flødevigen	360	54-66	54-80	54-88
1934 Topdalsfjord	122	54-90	54-74	54-77
1935 Topdalsfjord	220	54-95	54-95	54-99
1938 Flødevigen	450	54-75	54-72	54-77
Total 1/8		54-69	54-75	54-88

Positive correlation is apparent in the means and in some of the samples, — in others it is negative. It may be that the material is not homogeneous enough. Positive correlation is only to be expected in homogeneous samples, — not in samples built up by individuals from different batches.

IV. The Pollack (*Gadus pollachius* L.).

The material is somewhat scanty. From the Oslofjord we have a fair number of counting for the 1938 year-class. This was richer than normal but not nearly so rich as in the case of the cod. The results of the countings of vertebrae are given in Tab. VIII and Fig. 9. In July the number varies from 53-24 in the Bonnefjord to 53-59 at Drøbak, from where it declines once more seawards. The number examined is low, but as we find the same trend in the case of the cod — Fig. 3 — the problem is of interest. It may be explained, by the way, that we have relatively deep water at Drøbak, with a narrow littoral border. Depth (combined with relatively low temperatures) has probably had some influence on the number of vertebrae of the cod and pollack in that district. In October 1938 the number of vertebrae in the district of Drøbak is lower than in July. As suggested when dealing with the cod, this may be the result of segregation brought about by the temperature. The segregation will, however, in the

FIG. 9 OSLOFJÖRD JULY 1938

POLLACK - NO OF VERTEBRAE
(A-GROUP)

between the different districts and the different years. It may be mentioned, however, that the number of vertebrae in the Sandnesfjord and Topdalsfjord is extremely high.

The material from Flödevigen for the years 1933 and 1934 demonstrates the great differences we may find in different shoals in the same district in the same season. In 1933 the values increased from 47.59 to 48.07 within a week, and in 1934 they decreased from 48.11 to 47.83 within two weeks.

Table 7. Sprat. Flödevigen 1933 and 1934.

Date	n	M cm.	σ
11/8 1933	116	3.34	47.59
15/8 1933	137	4.08	47.88
16/8 1933	107	5.16	48.07
17/8 1934	170	6.47	48.11
27/8 1934	149	6.34	47.97
28/8 1934	206	6.47	47.83

of the pollack, being a southerly form, naturally work in a direction other than in the case of cod. The larger specimens of cod will in autumn migrate into the littoral region, whereas pollack will leave it. The low values in October may also be ascribed to immigration of fish from the lower No. of vertebrae.

The number of vertebrae from the Skagerak is given in Tab. VIII. For the more representative samples it varies from 52.74 to 53.20. The values are distinctly lower than those found in Oslofjord. But as the countings do not refer to the same year-classes, we can say no more about it.

In the two samples we have examined the correlation between size and number of vertebrae.

Flödevigen 10. and 21. August 1933.

Year-class	n	Small	Medium	Large
1931	207	52.59	52.81	52.89
1932	603	52.97	53.17	53.29

The correlation is good.

The Sprat (*Clupea sprattus* L.).

During our investigation on the occurrence of young cod-fishes in the littoral region, we sometimes happened to get small samples of sprat. This material has been forwarded to Paul Bjerkkan in Bergen for further examination. Mr. Bjerkkan has been kind enough to permit me to use his results as to the number of vertebrae. Tab. IX gives the results. It will be seen that only occasional samples have been obtained and it is impossible to draw any correlation

From Tab. 7 it is evident that the number of vertebrae in 1933 increases with the average size of the individuals, the space of time between the three samples — 5 days — being of no importance. In 1934, however, the last two samples belong to fish which are of the same size, and therefore relatively smaller than the earliest catch. The correlation between size and number of vertebrae is thus here also a positive one.

In the case of the sprat the correlation between number of vertebrae and length of the individual of the same year-class is very marked. The average number of vertebrae for 33 samples, each with a minimum of 100 specimens, is 47.85 — 47.98 — 48.13 in the small, medium and large.

Summary and Discussion.

Since 1928 we have occasionally collected material for countings of vertebrae of different species of the cod family, and partly also the rays of the second dorsal fin of the cod.

The quite young fish are collected in the littoral region during our experimental fishing with a fine-meshed seine. The older year-classes are supplied during experimental fishing with traps at Flödevigen at a depth of 15 metres, and partly from the commercial fisheries. The spawning cod for the hatchery is bought in the market.

During experimental fishing with the seine we have occasionally taken samples of young sprat. This material has been dealt with by Mr. Bjerkkan, and the results arrived at are quoted here with his permission.

Cod. The 1938 year-class was extremely rich. As mentioned by Löversen, the biology of the young cod that year was quite extraordinary. It

Table IX. Sprat. α -Group

Year-Class	1927		1928		1930		1931		1938	
	φ	n	φ	n	φ	n	φ	n	φ	n
<i>Skagerak Coast:</i>										
Soppekil	—	—	—	—	—	—	47-71	(90)	48-07	(4)
Hellefjord	—	—	—	—	—	—	—	—	48-08	(2)
Kiltsfjord	—	—	—	—	—	—	—	—	—	—
Stølefjord	—	—	—	—	—	—	—	—	—	—
Risør skjærgård	—	—	—	—	—	—	—	—	—	—
Søndeledfjord	—	—	—	—	47-81	(560)	47-70	(118)	—	—
Sandnesfjord	—	—	48-67	(944)	—	—	—	—	—	—
Flødevigen	48-00	(99)	—	—	—	—	—	—	47-80	(3)
V. Vallesværffjord	—	—	—	—	—	—	—	—	47-75	(13)
Topdalsfjord	—	—	—	—	—	—	—	—	48-26	(1)
Trysfjord	—	—	—	—	—	—	—	—	—	—
<i>The Oslofjord:</i>										
I Bonneffjord	—	—	—	—	—	—	—	—	—	—
II Bygdøy—Håkavik	—	—	—	—	—	—	—	—	—	—
III Nærnsnes—Håøya	—	—	—	—	—	—	—	—	—	—
V Holmestrand	—	—	—	—	—	—	—	—	—	—

lived partly pelagically in the surface layers till late in summer. The material collected of that year-class was most representative, and is therefore dealt with separately.

As to the material from the other years it is evident that the number of vertebrae of the cod in the Oslofjord varies somewhat around 51-90. On the Skagerak coast it is approximately 52-07, with the highest values in the western part. This refers to the young in their first summer and autumn.

The 1938 year-class had a number of vertebrae of approximately 51-95, 52-00 and 52-05 respectively in the inner, outer Oslofjord and on the Skagerak coast. In the Oslofjord and on the eastern part of the Skagerak coast the number of vertebrae of that year-class was thus higher than usual, on the western part it was lower. In the inner part of the Oslofjord (Bonneffjord) the number of vertebrae in July 1938 was in conformity with what is normally found. It rises outwards, with a maximum near Drøbak, after which it once more declines. It is suggested that the population in the inner fjord was a local one. As to the district near Drøbak it was reasonable to assume that most of the codling had originated from those living pelagically.

During the autumn the number of vertebrae rises in the Bonneffjord. This is probably caused by codlings invading the littoral region from deeper waters, possibly from the district near Drøbak. In the outer fjord the values are very high in March and October 1939. This is ascribed to the well-known fact that in the littoral region we have during autumn and spring ordinarily an invasion of fish from deeper waters.

The high number of vertebrae near Drøbak is apparent also when all samples are summed up for the years 1938 and 1939. This indicates that the interchange of the young cod between the inner and outer fjord must be insignificant.

On the Skagerak coast it seems that the number of vertebrae rises towards the west. This is the case for the 1938 year-class, and is also apparent when all countings are totalled.

It appears that the number of vertebrae of the older fish often is lower than that of the younger fish for the same year-class. During the summer the older fish normally leave the littoral region. Those left are slow growing. As to the spawning cod, we prefer, when buying the fish, those caught in the littoral region, as they are of the highest vitality. According to Schmidt (1930) the cod from near land have a low number of vertebrae.

The correlation between size of the individuals of the same year-class and number of vertebrae is very slight. It may be that the material is not homogeneous enough, different populations being represented. The correlation is highest in the district of Drøbak.

The number of rays of the second dorsal fin of the grown-up fish from the Skagerak coast varies very much from year to year. It seems if some periodicity may occur.

No correlation can be stated between the number of vertebrae and number of rays, whether positive or negative. The variation in number of vertebrae and number of rays is evidently caused by different factors, or the critical stage of development may differ as between vertebrae and rays. Two populations may have the same number

of Vertebrae.

1934	1935		1936		1937		1938		1941		Year-Class
<i>n</i>	<i>v</i>	<i>n</i>	<i>v</i>	<i>n</i>	<i>v</i>	<i>n</i>	<i>v</i>	<i>n</i>	<i>v</i>	<i>n</i>	
(231)	—	—	—	—	—	—	—	—	—	—	<i>Skagerak Coast:</i>
(203)	—	—	47-69 (205)	—	—	—	47-90 (169)	—	—	—	Soppekil
	48-00 (104)	—	—	—	—	—	—	—	—	—	Hellefjord
	—	—	48-02 (129)	—	—	—	—	—	—	—	Kilsfjord
	47-94 (343)	—	—	—	—	—	—	—	—	—	Stølefjord
	48-04 (136)	47-86 (167)	—	—	—	—	—	—	—	—	Risør skjærgård
	—	—	—	—	—	—	—	—	—	—	Søndeledsfjord
(525)	47-75 (225)	47-97 (146)	—	—	—	—	—	48-11 (283)	—	—	Sandnesfjord
	—	—	—	—	—	—	—	—	—	—	Flødevigen
(72)	48-16 (131)	—	—	—	—	—	—	—	—	—	V. Vallesværffjord
	47-89 (154)	—	—	—	—	—	—	—	—	—	Topdalsfjord
	—	—	—	—	—	—	—	—	—	—	Trysfjord
	—	—	—	—	—	—	48-04 (159)	—	—	—	<i>The Oslofjord:</i>
	—	48-05 (167)	47-83 (110)	—	—	—	48-19 (195)	—	—	—	I Bonnefjord
	—	47-89 (297)	—	—	—	—	—	—	—	—	II Bygdøy—Håkavik
	—	—	47-84 (122)	—	—	—	—	—	—	—	III Nærnes—Håøya
	—	—	—	—	—	—	—	—	—	—	V Holmestrand

vertebrae, but a different number of rays, and *conversa*. It is also stated that the number of vertebrae and rays does not vary in accordance with the temperature of the season. But as the temperature is unknown in the critical stage of formation of the vertebrae and rays, nothing can be said as to the actual problem of the influence of temperature.

Ing. In the inner Oslofjord the number of vertebrae for the 1938 year-class is 54-66, and in conformity with the values for the outer fjord for 1933 and 1939, respectively 54-69 and 54-53. In the value from the outer fjord is 54-89, and the difference from the inner fjord during the year is significant.

In the Skagerak coast the value for 1938 is high, and intermediate to the other years. The number of vertebrae of the whiting is relatively high in 1933 and 1937, — high in 1934 and 1935. In the case of the cod the number of vertebrae of the 1938 year-class was relatively high in outer Oslofjord, — otherwise it was quite normal. A positive correlation between size and number of vertebrae occurs in some samples and in other years.

Dröbak. The countings for the 1938 year-class in Oslofjord demonstrate the same phenomenon as stated in the case of the cod. In July the counts are highest in the district of Dröbak. In October the number of vertebrae here is lower than in July. It is tentatively ascribed to segregation, — the larger fish, in contrast to the cod, leaving the littoral region when the water temperature is falling, or to immigration. From the

Skagerak coast we have no countings for that year-class. The values for the other years are distinctly lower than in the Oslofjord in 1938.

The correlation between the number of vertebrae and the size of individuals of the same year-class is well pronounced.

Sprat. Occasionally some sprat of the 0-group are caught in the littoral region in the seine used for catching codfishes. The material is, therefore, not fit for discussing the values for the different districts. It is of interest to note the great differences in the number of vertebrae found in different shoals in the same place within a very short space of time. The shoals with the largest individuals have the highest number of vertebrae.

The correlation between the size of the fish and number of vertebrae of the same samples is high.

The material examined gives a strong warning as to the necessity of being very scrupulous when collecting material for vertebrae-countings. It is well known that the number of vertebrae in one place differs with the different year-classes. It varies, however, also within the same year-class from season to season, — this evidently being caused by segregation according to temperature.

It will be noted that the correlation between the number of vertebrae and the size of the fish is greatest in sprat and pollack, — the two species forming shoals. It must be expected that the homogeneity of the material here is high.

The conclusion which may be drawn from the vertebrae-countings as to the biology of the different species will be dealt with in another paper.

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Baltic Area.

INTRODUCTION.

Contributions to this report have been received from Dr. Aage J. C. Jensen, Copenhagen, Dr. Harald Alander, Stockholm, and K. A. Andersson, Stockholm. Furthermore, before going to press, a Polish contribution on herring of the Gulf of Danzig has been received from W. Cieglewicz and K. Posadzki.

Dr. Jensen discusses temperature, salinity, oxygen content of the water, the fat content of herring, the fluctuations of the year-classes of herring, plaice, flounder and turbot, and the growth-rate of herring in the Bornholm area.

Dr. Alander deals with the salinity and temperature of the Baltic and with the fluctuations of herring in the Baltic north of the Bornholm Sound. Dr. Andersson describes the year-classes of the herring in the Sound and the Bornholm area as well as the changes in the growth-rate of the herring.

As to the results, the following may be said: Since 1940, the temperature of the water has been subject to strong variations; specially remarkable was the low temperature of the southern and central Baltic during the summers of 1942 and 1943, though to a lesser degree — of 1940. The salinity has been unstable.

Observations of temperature, salinity and oxygen content made on the deep water near Bornholm have also proved that the exchange of water between the Kattegat and the Baltic has been weak during some years and strong during others. As regards the age composition of herring during 1940—44 the autumn-spawning year-class of 1937 was absolutely dominant in the open sea NE., and NW. of Bornholm. Besides, Dr. Jensen found that also the year-classes 1938 and 1942 were numerous at Bornholm.

It is further shown that the very strong 1937 year-class has given very abundant yields to the fishery during the years 1940—44.

In the central Baltic the age composition of the herring was similar to that in the southern Baltic. In the Gulf of Bothnia, at a depth of 80 to 90 m. Dr. Alander ascertained the presence of a large number of old herring — up to 12 and 15 years — consisting of both autumn and spring-spawning year-classes. Their length also was quite exceptional for

these waters. Many fish measured 23 and 24 cm., and some even 25 and 26 cm. Dr. Alander seems also to be able to prove that the herring of the Baltic, as they grow older, migrate from the coasts to deeper water in the open sea.

The greatest importance, however, of the investigations carried out in the Baltic area lies in the fact that they are concentrated upon the problem: The influence of the environments.

One of the problems dealt with is: How do the strong year-classes originate? It is shown that in the waters under discussion there exists a distinct correlation between the occurrence of strong year-classes of autumn-spawning herring and a high temperature in the autumn and the following winter. Dr. Jensen further suggests that high temperatures during the period March—May favour the origin of strong year-classes of plaice; on the other hand, temperature does not seem to have any influence on either flounder or turbot.

It is also once more proved that the growth-rate of herring is smaller within a strong than within a weak year-class.

Within the Baltic area the growth-zone in the scales of the herring was very small in 1942, indicating a small growth increment of the herring that year. It is shown that this is in all probability due to the extraordinary low temperature of the water that summer. In 1940 also, the growth was weak, but not so weak as in 1942; the temperature in 1940 was also low, but not so low as in 1942.

It has thus been distinctly proved that the temperature of the water is of great importance for the occurrence of strong year-classes — at least in autumn-spawning herring — and for the growth-rate of the herring. The salinity, on the other hand, does not seem to have any such influence.

Dr. Jensen introduces into the discussion a new and very interesting environmental factor, i.e., the fat content of the plankton. He shows that this fat content varies strongly during several years. It seems as if the fat content of plankton is dependent upon the surface temperature of the water and the cloudiness of the sky. Dr. Jensen has also found a distinct correlation between the fat content of plankton and the growth-rate of herring.

K. A. Andersson.

ENVIRONMENT.

Salinity and Temperature in the Baltic during the Years 1937 to 1944.

By

Harald Alander.

DURING the recent war years all oceanographic work has necessarily suffered considerable restrictions which even Sweden has felt, though not a party in the war. Large parts of the Skagerak, the Kattegat and the Baltic, where Swedish work is generally carried out, were for instance barred by mines or otherwise closed; the research vessel "Skagerak" was taken over by the naval authorities, and as the lightships were withdrawn the hydrographic observations made from them had to be discontinued. Consequently the most important sources for data regarding hydrographic conditions in the waters round Sweden were no longer available.

As far as the Baltic is concerned, however, the investigations could be continued, though to a somewhat limited extent. The research vessel "Eysstrasalt" was on duty for two to five months a year and consequently quite a number of hydrographic observations could be made. Under the prevailing circumstances it was not always possible to direct the vessel to such places where, from a scientific point of view, the most valuable samples could be taken, and this often left gaps in the series of observations. As it is, we must be glad that any samples at all could be collected.

As far as available, however, the material gives a relatively clear idea of the hydrographic conditions in the Baltic, and I feel therefore justified in publishing a review of the most important results.

As far as possible the review will show the variations in temperature and salinity which have taken place in various parts of the Baltic. The last years of the preceding decade are included so

as better to illustrate the variations of the water temperatures, especially those occurring in connexion with the severe ice winters 1939/40, 1941 and 1941/42. The data are taken partly from the *Bulletin Hydrographique*, and partly from the observations of the "Eysstrasalt".

The areas chosen are such which could be considered representative and from which almost complete series of observations were available. In various years, the various samples of a series could not always be taken at the same locality (see above), but comparisons between neighbouring stations indicate that divergencies of this kind were insignificant compared with the important changes which had taken place during the years under review.

The data regarding the southern Baltic originate from samples taken north-east of Bornholm. During the years 1940—42, however, the samples were not taken in the Bornholm Deep, but at 50 m. depth nearer the Swedish coast. The samples from the central Baltic originate from the deep area between Landsort and Gotland, while all samples from the Gulf of Bothnia were taken off "Å" lighthouse.

The data for the various areas have been arranged in diagrams (see Figs. 1—6). The salinity diagrams indicate the time of the year when the sample was taken and the level at which water layers of various salinity were found. The levels were determined by interpolation of the observed values, and they cannot, therefore, be absolutely exact, but the deviations from the actual conditions may be supposed to be rather negligible. Observations taken during consecutive years are connected by straight lines.

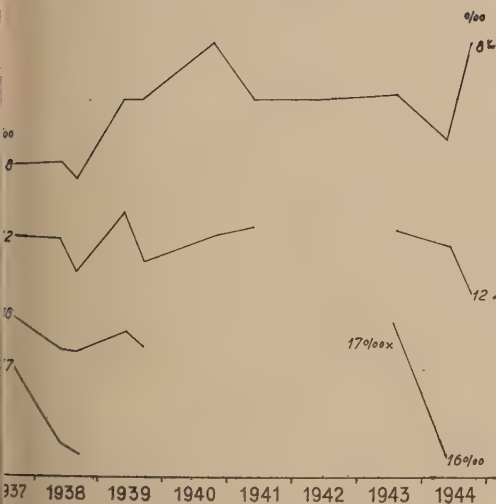


Fig. 1. Salinity in the southern Baltic.

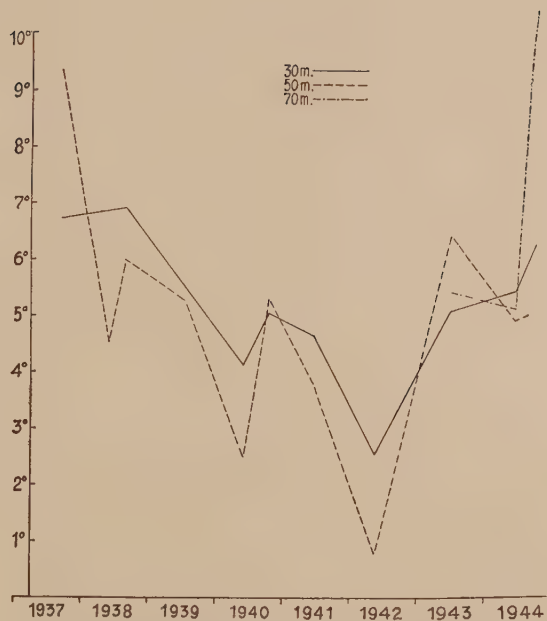


Fig. 2. Temperature in the southern Baltic.

the temperature diagrams indicate the temperatures at 30 and 50 m. depth and, as far as possible, also at 70 and 90 m. depth. At 30 m. depth the seasonal variations of temperature are relatively small while great variations occur during longer periods. As the herring spends an important part of its life in these depths it is very probable that the hydrographic conditions of these layers have a great influence on its life.

southern Baltic. Fig. 1 shows at what levels of 8, 12, 16, and 17 ‰ salinity was found during the years 1937—1944. Unfortunately it has been impossible to follow by annual observations the distribution of water layers with the exception of that of 8 ‰ salinity, and this is regretted, because during recent years the curves indicate very interesting salinity conditions in the Bornholm Deep. It must be noted that the occurrence of water of 17 ‰ salinity is exceptional in this area¹⁾. According to the

data published in the *Bulletin Hydrographique*, water of so high a salinity has not been found in the last 20 years except in 1925. During the years immediately before 1937 the salinity in the Bornholm area had been very low; it is therefore obvious that a strong inflow of salt water from the Kattegat must have taken place — probably during the autumn of 1936, since water of 17 ‰ salinity was found already at 80 m. depth during the summer of 1937. In 1938, the curves descend to attain higher values again in 1939 — excepting the 17 ‰ curve. Water of this salinity could not even be found at a depth of nearly 100 m. so that the above-mentioned rise of the other curves must be ascribed to an inflow of water masses of great volume but rather low salinity. The observations of 1943 proved again the presence of water of 17 ‰ salinity in the Bornholm Deep, and that already at a depth of 75 m. A new strong inflow of more saline water has evidently taken place during the intervening years. In 1944, the salinity was again very low. It is obvious that since the summer of 1943 the inflow of water from the west was small, and the mixing of bottom water and

¹⁾ Vide Aage J. C. Jensen, Rapp. et Proc.-Verb. 102, I, Fig. 6.

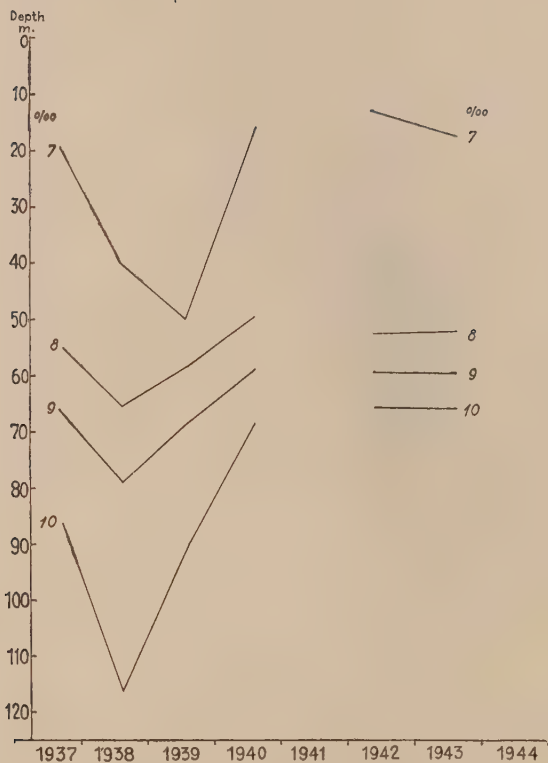


Fig. 3. Salinity in the central part of the Baltic.

the less saline Baltic water seems to have proceeded pretty quickly. The 8 ‰ salinity curve shows also that the salinity has increased quite considerably during the years following 1937.

Fig. 2 gives the temperature at 30 and 50 m. depth in the Bornholm area during the same period. Most remarkable is perhaps the occurrence of particularly low temperatures during 1940 and 42. The high temperature at 50 m. depth in 1937 seems to be parallel to the conditions at 70 m. depth in 1943 and 44 (see the dotted curve). As late as in June 1944 water of low temperature and high salinity was met with here, but in the beginning of October there appeared at this depth a layer of warm water of rather low salinity (about 12.5 ‰).

2. Central Baltic. Fig. 3 presents the salinity conditions. The curves give the levels for 7, 8, 9, and 10 ‰ salinity. The various curves show quite a good parallelism which depends to a high degree upon the fact, that the mixture between the inflowing more saline and the outflowing less saline waters is farther developed here than in the

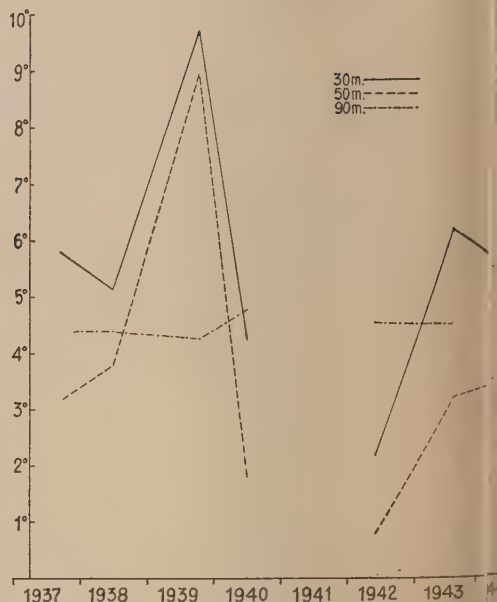


Fig. 4. Temperature in the central part of the Baltic.

southern Baltic. The curves show an increase in salinity after 1938 which is clearly connected with the above-mentioned strong inflow of salt water into the southern Baltic. The curve for 10 ‰ salinity, however, indicates a minimum one year later which is perhaps related to the fact that practically all surface water comes from the north up to there the increase in salinity had not yet proceeded.

As regards the temperature conditions in the central Baltic, the temperature curves at 30 and 50 m. depth show a very striking parallelism (see Fig. 4.). The 90 m. curve, however, is quite smoothly, as was to be expected. As in the southern Baltic, the temperature was very low during 1940 and 42, in 1939, however, it was extraordinarily high, in contrast to that in the southern Baltic.

3. Gulf of Bothnia. Even here the salinity seems during later years to have been subject to a certain increase, as may be seen from the curve which shows at which levels water of 5, 5.5, and 6 ‰ salinity was found during the years



Fig. 5. Salinity in the Gulf of Bothnia off Agö.

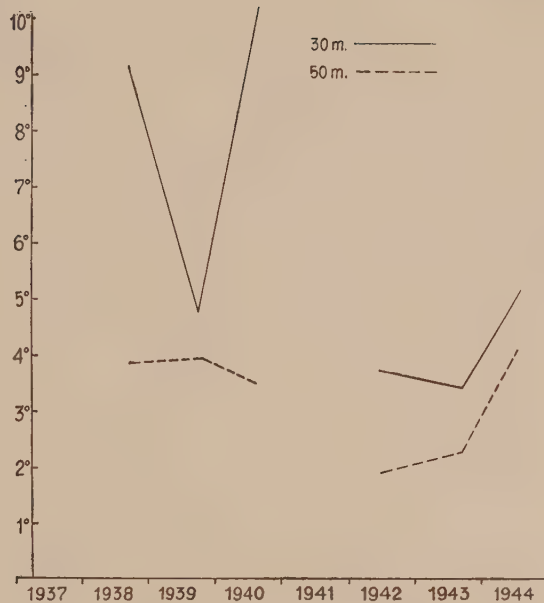


Fig. 6. Temperature off Agö.

It is remarkable that both the Gulf of Bothnia and the southern Baltic show high salinities in 1943 and a decided decrease in 1944. In probability the inflowing bottom water cannot reach the Gulf of Bothnia from the southern Baltic during the short period of 6 or 12 months, and it is therefore likely that the relatively high salinity off Agö during 1940 and 1943 goes together with increase in salinity in the southern Baltic as was proved already in 1937. A continued inflow of salt water from the central Baltic may probably for some time yet be expected to cause presence of high salinities in the Gulf of Bothnia.

The curves in Fig. 6 give the temperature conditions at 30 and 50 m. depth off "Agö" light-house. Until 1940 the two curves run quite differently, but during the last three years they differ very slightly. It seems as if the cold winters — which were not so abnormally severe in the Gulf

of Bothnia (taken relatively) as farther to the south — did not cause such a thorough change of temperature at the greater depths. On the other hand, it seems as if the volume of the surface layer, which is warm in summer, has decreased considerably. This became evident through the fact, among others, that the herring could be caught in considerably lesser depths during recent years than at the end of the thirties. A striking fact may be noted here — and no explanation is given — that during 1939 the temperature was very low off Agö at 30 m. depth, while being remarkably high in the central Baltic.

The present examinations thus seem to prove that the hydrographical conditions in the Baltic have been rather unusual during recent years. From K. A. Andersson's paper regarding herring in the southern Baltic (see this volume, p. 166) it may be inferred that they have had very obvious biological effects.

Hydrography at Bornholm.

At Christiansø the surface temperature (and salinity) is observed every day at 8 o'clock.

From the Danish Biological Station observations at various positions and in different depths have been carried out in connection with the biological investigations.

The vertical distribution of temperature and salinity at two places: in the deep SE. of Christiansø and N. of Hammeren, respectively, has been shown in Figs. 1 and 2.

In the surface temperatures at Christiansø we note the low winter temperatures of 1940, 41 and 42.

The diagrams Figs. 1 and 2 from the summer illustrate the effect of the cold winters on the temperature of the intermediate water layers. Especially in 1942 the temperature was very low in a rather thick layer.

The salinity of the bottom layer of the Bornholm basin.

In a depth of 90 m. the salinity c. 3 Sm. SE. of Christiansø was the following (cp. Fig. 1):

Year	Date	Salinity
1939	9/8	16.5 ‰
1940	20/7	17.5 ‰
1941	20/8	16.0 ‰
1942	20/8	17.3 ‰
1943	25/8	16.7 ‰

It will be seen that during these years remodelling of the bottom layer has occurred twice, where a pronounced rise in the salinity has been found

between 1939 and 1940
between 1941 and 1942

The oxygen content of the bottom layer at Bornholm.

3 Sm. SE. of Christiansø the following oxygen content has been found:

Year	Date	Depth	O ₂	100 · O ₂ : O
1939	9/8	84 m.	1.50 ccm.	18.9 ‰
1939	9/8	95 m.	1.38 ccm.	17.4 ‰
1943	25/8	80 m.	0.96 ccm.	12.4 ‰
1943	25/8	87 m.	0.85 ccm.	10.0 ‰

They confirm that the bottom water in each of these two years has been stagnant for a longer or shorter time (more or less 1½ years).

Aage J. C. Jensen

Plankton Conditions at Bornholm.

The fat content of the plankton has been determined according to Wimpenny's method.

The samples were taken with the Hensen net in vertical hauls from surface to bottom.

As regards the fluctuations from year to year in the fat content the temperature and the light may be supposed to be among the determining factors. If we compare the fat content with the surface temperature in July—August at Christiansø

we find a rather distinct correlation. The amount of cloud (in tenths of the whole sky) at Drogden, which is inversely proportionate to the hour of sunshine is the material for comparison which is the most easy to get, and has been shown in Table 1. It also shows a distinct correlation with the fat content. Possibly these collocations may give some hints as to the causes, but a decision of them naturally demands a crucial investigation.

Aage J. C. Jensen

Fat Content in Plankton

(determined by "Fiskeridirektoratets Forsøgslaboratorium").

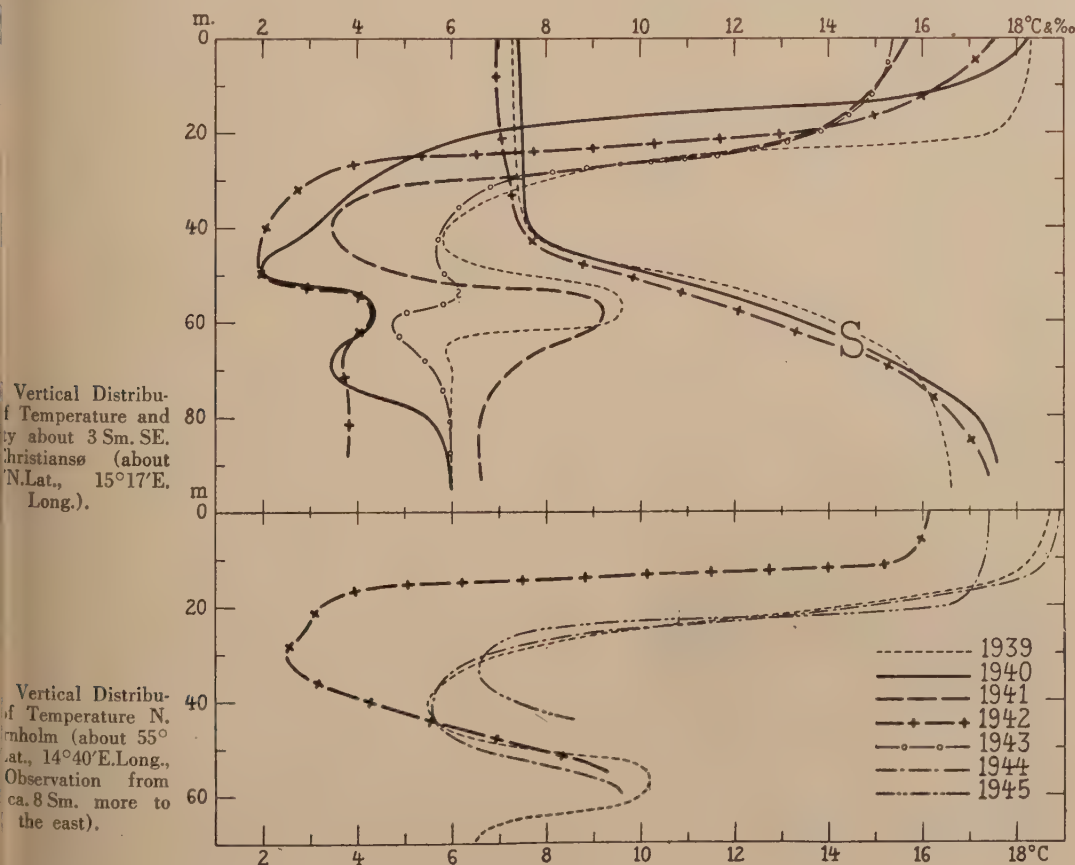
Year	Month	No. of samples	Fat Cont. ‰ average	Range	Surf. Temp. ° C.	Clouds July-Aug.
1942	VIII	7	16	8—21	15.4	6.0
1943	VIII	19	25	11—37	16.8	5.8
1944	VIII—IX—X	3	33	25—42	18.1	5.4
1945	VIII—X	3	16	8—24	16.7	6.0
1945	VII—VIII—X	6	23	8—35		

Table 1.

Surface Temperature at Christiansø, N. of Bornholm

(from The Danish Meteorological Institute Nautical Department).

Year	Oct.	Nov.	Dec.	Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.
1931	10.2	7.7	5.0	1932	3.5	2.2	1.3	2.6	5.9	10.8	17.3	18.2	14.5
1932	11.1	7.1	5.4	1933	3.7	2.1	1.7	3.3	6.7	12.4	16.6	16.9	15.9
1933	12.1	8.0	5.0	1934	3.4	2.8	2.8	4.2	8.3	12.3	16.5	17.3	16.5
1934	12.8	8.9	7.1	1935	4.2	2.6	2.3	3.7	6.3	11.9	15.8	16.2	15.0
1935	11.8	8.5	5.6	1936	4.2	2.3	1.8	3.1	6.7	11.9	16.9	16.4	14.5
1936	10.3	8.2	6.0	1937	3.6	1.4	0.9	2.6	7.4	11.5	16.9	19.2	16.6
1937	13.0	9.3	4.5	1938	2.7	2.4	3.0	4.1	6.6	10.8	15.6	18.5	15.2
1938	12.4	9.7	6.3	1939	3.8	3.1	2.8	4.0	6.6	12.3	15.9	19.0	17.5
1939	12.3	8.8	5.6	1940	2.3	—0.2	—0.3	0.8	4.4	11.8	16.7	15.6	10.6
1940	9.3	6.4	4.2	1941	1.4	—0.3	—0.1	0.9	3.2	9.3	17.0	15.9	14.3
1941	10.6	6.0	4.5	1942	1.9	—0.4	—0.4	0.3	3.5	9.6	14.1	16.8	15.7
1942	11.4	7.3	3.6	1943	2.2	1.9	2.3	4.0	8.1	13.1	16.7	16.8	14.1
1943	12.2	9.8	5.8	1944	4.0	3.3	2.6	3.2	5.3	10.5	17.4	18.8	15.0
1944	11.7	7.9	5.5	1945	3.4	2.2	2.4	4.3	7.3	12.1	16.2	17.2	16.3
—1930	11.1	8.1	5.5	—	3.3	2.1	1.8	3.0	6.1	11.0	15.2	16.0	14.1
—1944	11.5	8.1	5.3	1932—1945	3.2	1.7	1.6	2.9	6.2	11.4	16.4	17.3	15.1



Denmark.

THE FISH.

Flatfishes.

Table 1.

Number of 0- and I-Group Plaice at the Baltic Area Coasts of Seeland and Møen, caught per 30 minutes with the Johansen Young Plaice Trawl. (Danish Biological Station).

	0-Gr.	I-Gr.	No. of Stat.
1944	5	1	13
1945	2	2	12
Mean of (1905—45)	3	1	(18 years)

The fishing experiments were carried out as usual in a depth of 1—1½ m. Fishing was not carried out at the coast east of Falster and was discontinued 1940—43.

Table 2.

Number of the 0-Group of Plaice, Flounder and Turbot caught at Bornholm per 30 min. with Push Net. (From the Danish Biological Station).

Year	No. of stations	Plaice	Flounder	Turbot
1932	6	1	187	1
1933	8	0.2	122	5
1934	8	23	31	13
1935	7	2	15	0.1
1936	5	4	165	3
1937	11	1	84	4
1938	11	6	26	6
1939	10	1	61	6
1940	8	0.4	122	12
1941	13	1	112	17
1942	13	2	112	4
1943	16	33	121	20
1944	13	18	469	132
1945	11	7	135	17
Average 1932—45		8	133	11

The quantity of the brood of the above species has been investigated each year since 1932 by fishing with a push net (shrimp net), where the frame below is 75 cm. broad. The fishing has been carried on in suitable places with plain sandy (or gravelled) bottom. The implement is pushed in front of a man for 10—40 minutes, the time determined *inter alia* by the extent of the area with good fishing ground. The fishery has been carried out in calm or almost calm weather or during offshore winds because experiments have shown, that the result is very much less when the man fishing can feel the pull of the waves on the implement.

The fishing experiments with the Johansen young plaice trawl, carried out regularly each year during 1933—39 (cp. A.B.I.) have been discontinued 1940—45.

The fluctuations in the strength of the year-classes of plaice in the Kattegat and the Belt Sea are correlated with the temperature of the water during the *winter* months, as demonstrated by H. Blegvad (1926), A. C. Johansen (1927) and the present author (1933). As regards the number of 0-group plaice caught every year at Bornholm, the correlation is most evident with the surface temperature of the months *March to May*, and in accordance with the fact that the spawning of the plaice in the Baltic proper takes place later than that of the plaice in the Belt Sea. It may be seen from Fig. 1 that other factors must contribute to the strength of the year-classes, e. g., since the temperature-conditions of 1939 (also in January—February) were just as good as in 1938.

The influence of the surface temperature in the winter or spring months on the strength of the year-classes of the flounder and the turbot is insignificant.

The yield of the fishery is to a certain degree determined by the size of the stock (see the following section). If we compare the number of the 0-group with the yield we note the significant fact that the size of the stock of commercial fishes does not determine the recruitment.

Table 3.

Yield of the Fishery of Plaice, Flounder and Turbot. (Baltic proper, in metric tons).

	Plaice	Flounder	Turbot
1932	799	870	19
1933	411	446	24
1934	223	331	15
1936	171	274	13
1937	174	262	13
1938	349	397	33
1939	212	233	24
1940	105	154	14
1941	121	94	9
1942	75	90	6
1943	42	107	5
1944	19	159	3

The decline in the catch of plaice and flounder has been caused mainly by overfishing (cp. R. P. et Proc. Verb., Vol. XLVIII, 1928 and Vol. LXXV, 1932). During the later years the highly remunerative fishery for cod has had the effect that the

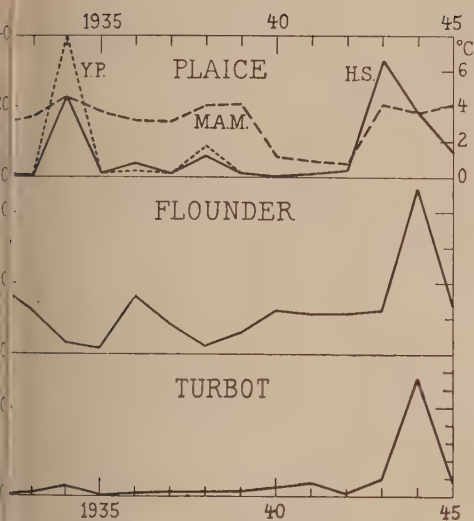


Fig. 1. Average Number of the 0-Group of Plaice, Flounder and Turbot caught at Bornholm per 30 min. haul with the push net (H.S.) and with the Hansen trawl (Y.P.) respectively, compared with the Surface Temperature at Christiansø in March—April—May.

fishermen have been little interested in the less remunerative fishing for flatfishes. The yield of each of these three species is to a certain degree depending one upon another and is not determined by the actual strength of the stock since they are caught together by the same gear. The fishing intensity and the yield of the fishery will be enlarged when the total stock of commercial fishes of these species is more abundant. Therefore the yield of the three species shows about the same course.

The increase in the yield of 1938—39 has undoubtedly been caused by the rather good 1934 year-class of plaice, the good year-class of turbot 1934 adding at the same time a higher value to the stock of commercial fishes, and the increased fishing for these species has caused an increase in the catch of flounder also, although no special improvement in the stock of this fish was ascertained.

The rather good year-classes of flounder since 1940 must have effected the rise in the yield of the flounder found since 1943.

The good year-classes of plaice in 1943 and 44 and of flounder and turbot in 1944 should increase the yield of the flatfishes in 1947—48 and 49.

Aage J. C. Jensen.

ring.

The Herring at Bornholm.

Table 1. Percentage Size Composition.

Length, cm.	14	15	16	17	18	19	20	21	22	23	24	25	Mean
1931—32—37	—	1	3	8	25	22	29	10	3	—	—	—	19.54
1939	5	8	14	6	6	11	15	19	8	6	2	1	19.50
1940	—	2	25	23	18	12	7	5	5	3	1	—	18.28
1941	—	—	—	5	32	30	19	7	4	2	1	1	19.72
1942	—	—	—	—	3	32	46	17	2	—	1	—	20.37
1943	—	—	—	1	4	16	24	21	22	8	3	—	21.33
1944	—	—	—	4	8	13	7	14	24	23	7	—	22.61
1945	—	—	1	2	12	22	25	23	11	4	2	—	21.57
Mean	1	1	5	6	14	20	22	14	10	6	2	—	20.14

Size and Age Composition of Commercial Catches.

In each of the years 1931, 1932 and 1937 only small sample has been examined. The average of these three samples corresponds more or less to "normal" at Bornholm. In each of the years 1940—45 2—7 samples of summer and autumn net catches have been investigated.

The size composition for a certain year is calculated from the average of the percentage distribution in each of the samples.

The fluctuations from one year to another in the sizes of the herring caught correspond to the fluctuations in the strength of the year-classes (cp. 2 and Fig. 1).

Table 2. Percentage Age Distribution
(Maturity II-VIII, most of them IV-V acc. to the scale of Johansen).

Age: Year	2	3	4	5	6	7	8+
							years
1939	31	13	17	12	8	7	10
1940	4	87	5	2	1	—	0.4
1941	1	25	72	2	—	—	—
1942	—	12	36	48	3	1	—
1943	19	21	16	20	15	7	—
1944	24	8	11	12	23	23	—
1945	7	54	14	6	6	8	6
Mean 1939—45	12	31	25	15	8	7	2

The figures for each year are averages of the percentage distribution in each of the samples.

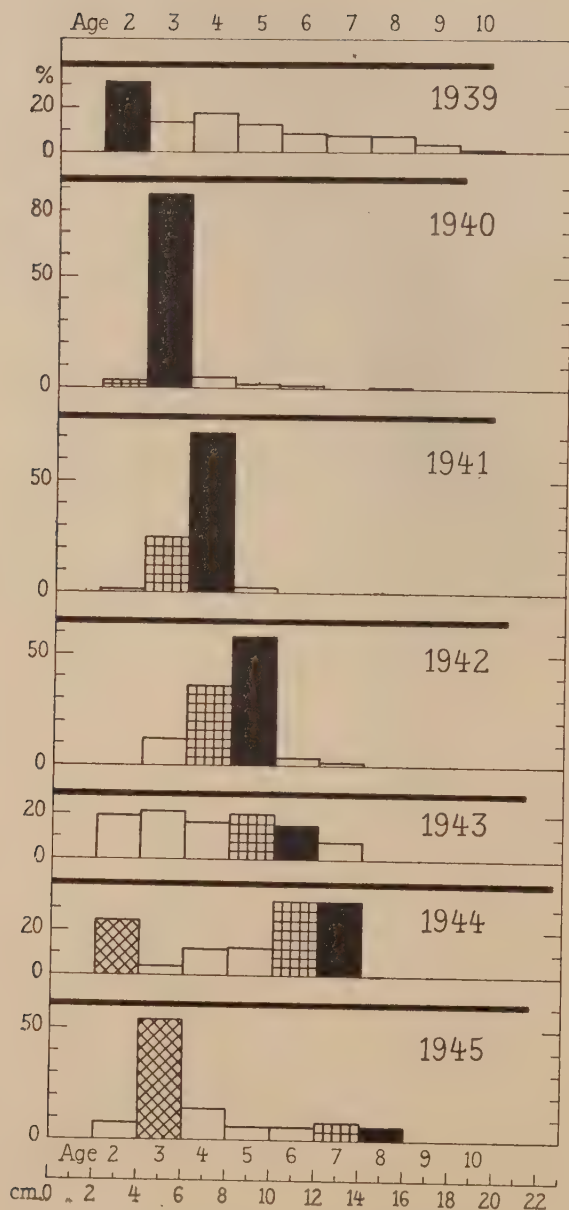


Fig. 1. The Percentage Age-Distribution of Herring at Bornholm in Summer and Autumn (cp. Table 2).
The heavy horizontal lines give the average lengths.

The rich year-class 1937 dominated the catch in 1939 (2 years old) and in 1940, 1941 and 1942. From 1942 the year-class 1938 (4 years old) constituted a rather great part of the catch. In 1945 these good year-classes were replaced by the rich year-class 1942 (3 years old).

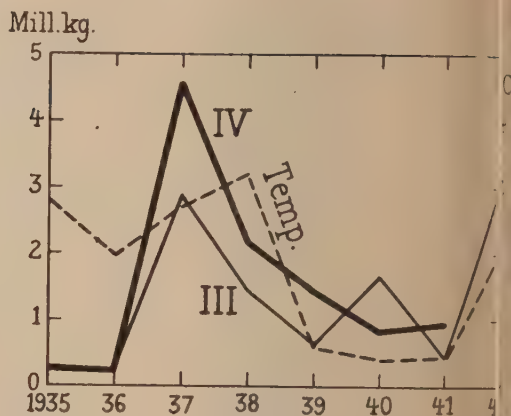


Fig. 2. The Relative Strength of the Year-Classes of Herring (Weight percentage of the Age-Group III in the Catch multiplied by the Weight Yield of the Herring Fishery at Bornholm) compared with the Surface Temperature at Christiansø in Jan., Febr., March of the following winter.

The main factor for the appearance of good or bad year-classes is undoubtedly to be found in the temperature of the first winter when the fry are tiny larvae. As is seen from the section Hydrography p. 153, the temperature of the water was very high in February—March—April 1938 and 1939. The survival of the fry in the following severe winters was apparently very bad. The temperatures in the first month of 1943 were rather high and the survival of the 1942 year-class was good (cp. Fig. 2). A contributory cause of the success of the survival of this year-class must be found in the still great abundance of large herrings: As shown by the present author (Journ. du Conseil, II, p. 44) there is at Bornholm a rather pronounced correlation between the amount of spawning herrings and the strength of the year-classes originating from them.

See Tab. 3, Average Length.

The lengths are calculated from the total number investigated in each sample (not percentage), i.e. each sample is weighted by its number. The lengths are shown in Fig. 3.

The distinct increase in the average lengths must for a great part be ascribed to the changes in the size of the meshes used. In 1939—40 when the small herring were plentiful the small-meshed nets were preferentially used; in the following years the catching ability of these nets was less than that of the larger-meshed nets and the former were as far as possible substituted by the latter. No doubt an increased growth-rate also played a rôle for the increase in the mean lengths.

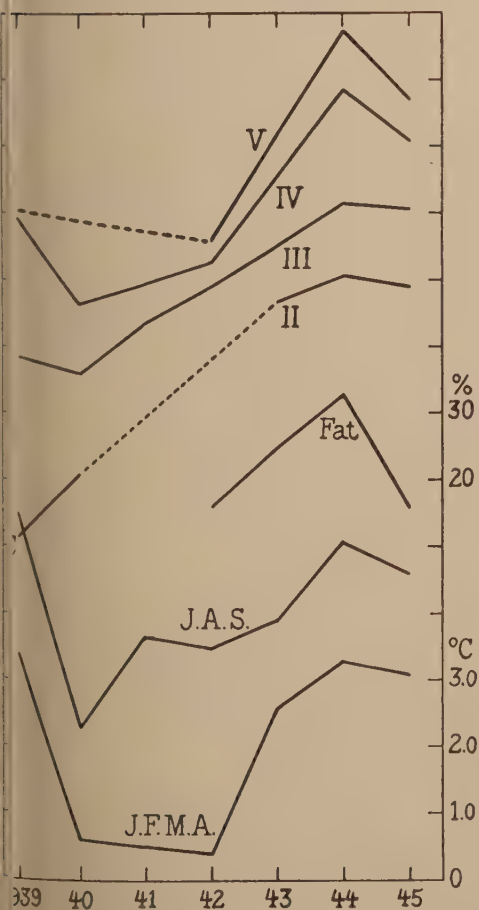
In Figure 3 the lengths are compared with the average temperature of the surface water at Christiansø in January—April and in June—September respectively. In Fig. 4 the difference between the length of certain year-classes in consecutive years

Table 3.

Average Length of each of the Age-Groups.

(In brackets number of specimens investigated).

Year	Month	II	III	IV	V	VI	VII	VII	IX
1939	VII—VIII	16.12 (317)	18.83 (100)	20.93 (124)	21.04 (89)	21.38 (73)	21.57 (63)	21.83 (46)	22.1 (18)
1940	IX	17.08 (24)	18.61 (915)	19.65 (74)	21.8 (11)	—	—	—	—
1941	VII—IX—X	17.9 (8)	19.34 (217)	19.92 (643)	21.1 (12)	—	—	—	—
1942	VII—IX—X	—	19.88 (119)	20.26 (386)	20.59 (533)	20.7 (31)	20.6 (9)	—	—
1943	IX	19.67 (83)	20.50 (86)	21.52 (55)	22.19 (64)	22.43 (53)	22.1 (26)	—	—
1944	VIII—X	20.03 (165)	21.12 (42)	22.81 (56)	23.74 (50)	23.59 (102)	23.87 (93)	—	—
1945	IX	19.9 (27)	21.07 (217)	22.08 (55)	22.7 (22)	23.1 (24)	22.7 (30)	22.8 (22)	—



(which to a certain degree is identical with the growth) has been compared with the temperature.

It is evident that here we find an increase in the temperature more or less corresponding to the increase in the lengths and growth.

In Figures 3 and 4 the fluctuations in the lengths and growth also have been compared with the average values of the fat content (cp. Environment p. 152). There seems to be a pronounced correlation between the fat content of the plankton and the growth (resp. the length of the age-group) of the herring.

The Racial Character of the Herring.

The average number of vertebrae of the year-classes of herring at Bornholm. (Number of specimens investigated shown in brackets).

1931	55.6	(25)	1938	55.47	(453)
1932	55.39	(33)	1939	55.72	(156)
1933	55.42	(31)	1940	55.50	(105)
1934	55.31	(48)	1941	55.38	(155)
1935	55.45	(64)	1942	55.48	(81)
1936	55.46	(112)	1943	55.7	(10)
1937	55.45	(1114)	Mean 1932—42	55.46	

The year-classes have been calculated from the number of rings in the scales irrespective of maturity. Of the herrings mentioned as year-class 1939 some immature fish seem to have been spring herrings of the year-class 1940 (see below).

The standard error of the extraordinary high mean for 1939 is 0.070 and for 1937 it is 0.021; thus the standard error of the difference between these means is 0.073 and the difference between them is 0.27 or 4 times as great.

Every year some of the herring caught at Bornholm are immature. For 90 herrings of maturity V, VI and VII (i.e. definite autumn herrings) of

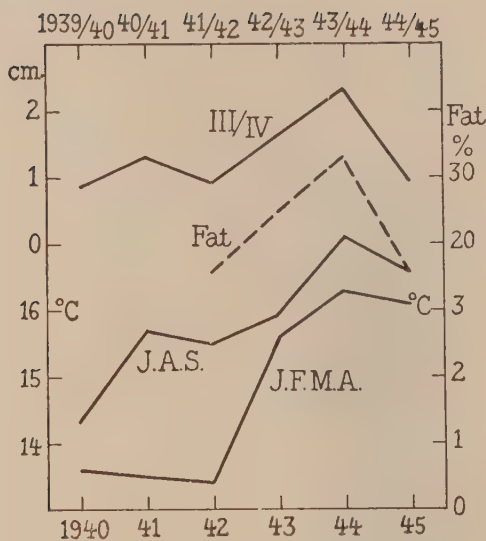


Fig. 4. The Difference of the Length of the II-Group and that of the IV-Group the ensuing Year, and the corresponding Difference of the Length of the IV- and V-Groups of Herring at Bornholm, compared with the Surface Temperature and Fat Content of the Plankton (cf. Fig. 3)

the year-class 1939 we find $V.S.=55.57$, $V.P.=23.82$ and $K_2=14.31$. It is seen that $V.S.$ is still rather high. Its standard error is 0.076 and comparing it with the $V.S.$ of the year-class 1937 we find the standard error of the difference = 0.101, and the difference 0.12. Thus a significant deviation from the normal of the $V.S.$ for the 1939 year-class cannot be stated.

Part of the immature herrings referred above to the 1939 year-class may have been South Baltic spring herring (Rügen spring herring, where acc. to Heincke $V.S.=56.00$) of the year-class 1940.

It is a quite peculiar fact that the number of vertebrae seem to have been very high in the year-class 1939, hatched in the year when the yield of the fishery was very small.

It may be noted that the temperature in the main spawning month, for the herring September, was extraordinarily high in 1939, about $1^{\circ}\text{C}.$ higher than in any other year since 1889, and that the high temperature reached rather great depths (cp.

Fig. 1 p. 153). On the other hand together with the high temperatures of September in 1937 and 1944 (16.6 and $16.5^{\circ}\text{C}.$ respectively) we find a normal and a very low number of vertebrae respectively. Thus in the hydrographical conditions we cannot find any explanation to the large mean of the total number of vertebrae of 1939, just as we cannot either from the hydrography of that year explain the low yield.

The mean value found is just as high as is normally found in the southern part of the Gull Belt, but a displacement of a spawning stock from there to Bornholm must be considered outside the possibilities.

The fluctuations of the mean numbers from year to year in most of the other years than 1939 are small and within the range of the uncertainty of the material. The high values found for the 1931 and 1943 year-classes on some few herings do not differ significantly from the "normal" value, 55.46.

Quantities of Herring landed.

The weight yield in metric tons of the herring fishery from Bornholm (landed by the Bornholm fishing boats) was the following:

1935	3864 tons	1941	6127 tons
1936	3309 tons	1942	6115 tons
1937	3929 tons	1943	8796 tons
1938	3646 tons	1944	6100 tons
1939	1441 tons	1945	6202 ¹⁾ tons
1940	3903 tons	Mean 1916—45	3440 tons

¹⁾ preliminary figure.

The low yield of the herring fishery in 1939 was no doubt due partly to a poor stock of commercial herrings originating from some bad 1930 years, partly also to a poor amount of copepods. It was noted this year that the copepods were grey or pinky-white. As I have stated in *Biol. Vol. I*, p. 175, west of Bornholm the 2- and 3-year-old herrings constituted the majority of the catch. As shown above this year-class 1937 and the following one dominated the stock of commercial herring during the following years. They are responsible for the very great fishery for herring down to the year 1944. Then in 1945 a new year-class 1942 began to dominate the catch.

Aage J. C. Jensen

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Comparative Studies of the Spring and Autumn Spawning Herring of the Gulf of Danzig.

By

W. Cieglewicz and K. Posadzki.

May 1936 we started comparative studies of the spring and autumn spawning herrings from the Gulf of Danzig in respect of their maturity, rate of growth, number of vertebrae and the sex and age composition of the catches made by the use of different gears. This work was carried out to the outbreak of the war and we had a small amount of data, which has been entirely lost, the tables worked out on the basis of 20 samples containing 4872 individuals of herrings collected during the period from May 1936 to April

the samples were taken once a month to the end of 100 individuals and at the time of more intensive herring fishery (September—November), were taken more often and with a larger number of individuals.

After the war we renewed our herring investigations and in the autumn of 1945 and spring of 1946 we examined 3008 individuals from the Gulf of Danzig, collected by Mr. M. Bula wa.

A detailed computation of the number of herrings in each sample together with date, locality, method of capture, average length and percentage of autumn and spring spawning herrings, is given in Table 1.

The discrimination of spring and autumn spawning herrings was made on the basis of gonad examinations.

From Table 1 it appears that our catches during the greater part of the year consist of autumn and spring spawning herrings mixed together, the majority being autumn spawners. During autumn and spring there are in some places pure shoals consisting of individuals of only one race.

For example, the catches of October 1936 and 1945 at Hel made by the use of stow-nets at a depth of 15 m. contained herrings belonging only to

the autumn spawning race, while the spring spawners at this time were caught by the use of trawls, far from the coast, at a depth of 60—90 m.

The catches of April and May near the Danzig coast and Fresh Firth (Frisches Haff) contained spring spawners only.

Maturation.

The stage of maturity of the herrings from each sample was determined according to the scale of Heincke (7) and the percentage of the fishes in the different stages of maturity is given in Table 2.

A. Maturation of Autumn Spawning Herrings.

Autumn spawning herrings during the winter, i.e., from December to March have gonads in stage II. In April the gonads of some fishes begin to develop entering stage III. The percentage of these fishes increases during May and June, and at the same time the further development of their gonads takes place. In July we find some mature fishes (stage V) and during August a single running one (stage VI). The percentage of mature and running fishes increases during September (Fig. 1) and in this month we observe the first spent individuals (stage VII).

The maximum number of mature fishes appears in the first days of October and in the second part of this month the maximum number of running ones. In November we observe the decrease of running fishes and increase of spent ones, the gonads of which return to stage II.

The analysis of the gonads of the herrings caught at Hel in October 1945 shows similar relations to those observed during the autumn of 1936:

Table 1.
Date, Place of Capture, Gear, Average Length and Proportion of Autumn and Spring Spawning Herrings in each Sample.

No. of Sample	Date	Place of Capture	Gear	Depth of Catch m.	Autumn spawners %	Spring spawners %	Number of Fishes	Average Length
1936/37								
1	16-V	Hel	stow-nets	15	89	11	100	20.0
2	8-VI	Hel — 0.5 sm. NNE.	stow-nets	5	86	14	100	21.0
3	2-VII	Bay of Puck	sprat trawl	30	85	15	100	18.1
4	21-VIII	Hel	stow-nets	25	96.1	3.9	102	22.1
5	14-IX	Hel — 8 sm. NE.	herring trawl	85	4	96	100	20.0
6	25-IX	Hel	stow-nets	17	99.1	0.9	110	20.5
7	28-IX	Bay of Puck	sprat trawl	45	60	40	50	12.7
8	29-IX	Hel — 8 sm. E.	herring trawl	75	5.9	94.1	102	21.3
9	1-X	Hel	stow-nets	10	96	4	912	18.0
10	8-X	Hel	stow-nets	10	99	1	789	20.5
11	10-X	Hel — 5 sm. N.	herring trawl	75	44	56	100	18.0
12	14-X	Kahlberg — 5 sm. N.	herring trawl	60	1	99	771	20.0
13	22-X	Hel	stow-nets	10	100	—	764	20.0
14	4-XI	Hel — 4 sm. SE.	sprat trawl	68	29.4	70.6	87	18.0
15	25-XI	Bay of Puck	sprat trawl	40	42.7	57.3	185	19.0
16	12-XII	Jastarnia — 1 sm. S.	stow-nets	8	78	22	100	21.0
17	9-I	Bay of Puck	herring trawl	30	69	31	100	19.0
18	5-II	Bay of Puck	herring trawl	35	70	30	100	20.0
19	24-III	Oksywie	stow-nets	8	79	21	100	21.0
20	13-IV	Oksywie	stow-nets	8	83	17	100	21.0
							4872	
1945/46								
1	3-X	Hel	stow-nets	12	100	—	644	22.0
2	10-X	Hel	stow-nets	15	100	—	367	22.0
3	7-II	Bay of Puck	herring trawl	35	5	85	21	19.0
4	7-IV	Sopot	stow-nets	5	—	100	814	20.0
5	30-IV	Frombork — Fresh Firth	small herring trawl	4	—	100	100	20.0
6	14-V	Katy Rybackie (Bodenwinkel)	small herring trawl	5	—	100	1062	18.0
							3008	
stow-nets — 18 mm. meshes herring trawl — 45—15 mm. meshes								
small herring trawl — 15—12 mm. meshes sprat trawl — 50—10 mm. meshes								

The spawning season of the autumn spawning race of herring in the Gulf of Danzig, therefore, takes place during September and October, attaining its maximum in the second part of October. This season is rather a long period, one meets single running fishes from August to the end of November.

According to Hesse (8) the spawning season of the herring depends upon the temperature of the water, which for the autumn spawners is between 11—14°C.

The temperature of the water at Hel measured by Demel (4) during September, October and November 1936 was as follows:

Date	0 m. °C	10 m. °C	20 m. °C
5-IX-1936	16.4	15.9	15.9
25-IX-1936	15.8	15.0	14.0
3-X-1936	12.1	12.0	12.0
10-X-1936	11.9	11.8	11.6
22-X-1936	10.0	10.0	10.0
5-XI-1936	8.7	8.7	8.7
26-XI-1936	6.2	6.2	5.7

From these observations it appears that the spawning of autumn spawning herring in our te-

Table 2.

Stage of Maturity of the Herring in each Sample, in %.

Date	Autumn Spawners Stage of Maturity							No. of fishes	Spring Spawners Stage of Maturity							No. of fishes
	I	II	III	IV	V	VI	VII		I	II	III	IV	V	VI	VII	
36/37	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
V	—	71	29	—	—	—	—	89	—	—	—	9	27	—	64	11
VI	—	54	36	10	—	—	—	86	7	26	—	—	28	—	39	14
VII	2	71	19	7	1	—	—	85	—	70	—	—	—	—	30	15
VIII	—	—	8	46	45	1	—	98	—	—	—	—	—	—	—	—
IX	—	—	—	—	—	—	—	—	—	100	—	—	—	—	—	100
IX	—	—	—	16	61	21	2	109	—	—	—	—	—	—	—	—
IX	—	—	—	—	—	—	—	—	—	100	—	—	—	—	—	97
X	—	—	—	—	77	22	1	96	—	—	—	—	—	—	—	—
X	—	—	—	—	42	58	—	99	—	—	—	—	—	—	—	—
X	—	—	—	—	15	7	78	44	—	88	12	—	—	—	—	56
X	—	—	—	—	—	—	—	—	—	84	16	—	—	—	—	103
X	—	—	—	—	—	84	16	188	—	—	—	—	—	—	—	—
XI	4	53	—	—	6	3	34	68	10	47	27	16	—	—	—	117
XII	1	99	—	—	—	—	—	78	—	68	18	14	—	—	—	22
I	—	100	—	—	—	—	—	69	—	—	35	55	10	—	—	31
II	—	100	—	—	—	—	—	70	—	—	47	50	3	—	—	30
III	—	100	—	—	—	—	—	79	—	—	—	33	67	—	—	21
IV	—	94	6	—	—	—	—	83	—	—	—	18	82	—	—	17
15/46	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
X	—	—	12	13	53	14	8	100	—	—	—	—	—	—	—	—
X	—	—	4	34	43	17	2	100	—	—	—	—	—	—	—	—
II	—	—	—	—	—	—	—	—	—	—	—	30	70	—	—	20
IV	—	—	—	—	—	—	—	—	—	—	—	1	78	21	—	100
IV	—	—	—	—	—	—	—	—	—	—	—	4	58	38	—	100
V	—	—	—	—	—	—	—	—	—	—	—	4	72	24	—	104

solace mainly when the temperature is from
°C.

The spawning grounds in the Gulf of Danzig
situated near the end of the Hel-Peninsula,
the herrings are caught by the use of stow-
a depth of 10—15 m. According to D e m e l
the spawning grounds are also situated along the
between Wladyslawowo and Rozewie.
The catches made in the shallow water at Hel by
of stow-nets and showing the highest percent-
d running herrings, contain fishes belonging
one race, i.e., autumn spawners. The spring
ers, as it was already mentioned, are caught at
the far from the coast by trawls. After the
ing season the shoals of autumn spawning
is are dispersed, they go into deeper waters
together with the spring spawners.

Maturity of Spring Spawning Herrings.

The spring spawning herrings start their matu-
rity already in October, when we find some fishes
in stage III. The percentage of these
increases during November and December and
at the same time further development of their go-
nads takes place. The highest percentage of mature

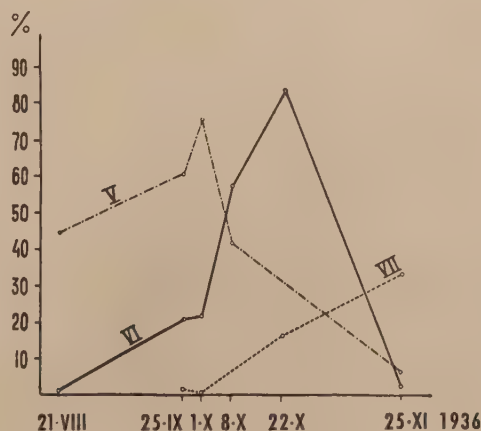


Fig. 1. Percentage of the Herring
in stage V — mature — — — — —
in stage VI — running —————
in stage VII — spent ··········

Table 3.

Length and Age of Autumn and Spring Spawning Herrings Caught at the Spawning Grounds

Length in cm.	14	15	16	17	18	19	20	21	22	23	24	25	26
<i>Autumn spawners</i>													
25·IX—22·X·36	0/0	—	—	1·6	6·7	13·9	17·4	24·8	22·7	10·2	2·2	0·5	—
3·X—10·X·45	0/0	—	—	—	—	0·4	1·3	1·8	9·2	40·2	32·6	12·2	2·0
<i>Spring spawners</i>													
7·IV—30·IV—14·V·46	0/0	0·1	0·5	4·1	8·9	13·8	16·8	22·4	20·9	10·3	1·7	0·3	0·1

Number of summer zones	2	3	4	5	6	7	8	Average length in cm.	No. of Fishes
<i>Autumn spawners</i>									
25·IX—22·X·36	0/0	0·9	24·0	21·9	20·8	21·9	10·5	—	2542
Average length in cm.		16·8	18·1	19·2	20·4	21·0	21·5	19·8	
3·X—10·X·45	0/0	—	3·0	7·4	50·0	33·6	6·0	—	1011
Average length in cm.		—	19·6	21·8	22·4	22·8	23·2	22·5	
<i>Spring spawners</i>									
7·IV—30·IV—14·V·46	0/0	4·8	65·3	26·4	3·0	0·4	—	0·1	1976
Average length in cm.		17·2	19·5	20·1	21·5	—	—	19·6	

herrings is found in April, and in May the spents have already appeared. In spite of the fact that the material obtained in 1936—37 did not contain running herrings of the spring spawning race — judging from the percentage of mature and spent fishes — we may assume that the spawning takes place between April and June. This supposition is confirmed by the examination of the herrings caught during the spring of 1946; the sample dated 7·IV·46 contained 21 0/0 of running fishes, that of 30·IV·46 — 38 0/0, and that of 14·V·46 — 24 0/0.

The spawning season of the spring spawning race is rather long in time, like that of the autumn spawners. Contrary to autumn spawners, which spawn every year near the end of the Hel-Peninsula, the spring spawners are very difficult to find in this place and then generally in single examples. Their spawning grounds are situated in a depth of 5 m, in the shallow waters along the Danzig coast, Fresh Peninsula (Frische Nehrung) and Fresh Firth (Frisches Haff).

According to Hessler the spring spawners spawn when the temperature of the water is between 6—10 °C. We have such temperature of our waters at the end of April and in May.

C. The Length and Age of Spawning Herrings.

The results of the length and age analysis of spawning herrings are given in Table 3. As it appears from this table the catches of autumn spawning herrings consist of fishes being from 16—26 cm, long and bearing from 2 to 7 summer zones on their scales.

As these herrings were caught by the use of stow-nets which have a selective influence on the composition of the catch, we may suppose that the

length of the herring at its first maturity much lower than that stated above.

The proportion of males and females is not equal with a small predominance of males which represent 51·3 0/0 of the catch. This proportion changes in the different age-groups but without regularity.

The average length of the males is little less than that of females of the same age.

The catch of spring spawning herrings consists of fishes 14—26 cm. in length, bearing 2—8 summer zones on their scales. The majority of fish have a length of 18—21 cm. and show 3—4 summer zones on their scales.

According to Lundbeck (11) the herring in the eastern Baltic attains its first maturity at the length 10—12 cm. and in the second year of life.

Rate of Growth.

The rate of growth of the herring was studied according to the Lea method (10) of back-calculation of growth, based on the scale of the fish. The average lengths of 1488 herrings from 14 samples caught during 1936, are given below.

	Autumn Spawners	Spring Spawners		Autumn Spawners	Spring Spawners
	cm.	cm.		cm.	cm.
l_1	11·82	9·02	t_1	11·82	9·02
l_2	15·72	13·79	t_2	3·90	4·77
l_3	17·85	16·55	t_3	2·13	2·76
l_4	19·37	18·27	t_4	1·52	1·91
l_5	20·40	19·74	t_5	1·03	1·32
l_6	21·40	21·09	t_6	1·00	1·00

the back-calculated lengths l_1, l_2, l_3 of autumn and spring spawning herrings show a large individual variation partly in similar limits. This variation is probably caused by the long period of the spawning season of the autumn and spring spawning herring in the Gulf of Danzig. The comparison of the average lengths l_1, l_2, l_3 and the average yearly length increments t_1, t_2, t_3 calculated as the difference of $l_1-l_0, l_2-l_1, l_3-l_2$ of autumn and spring spawning herrings appears from the table. Both races grow rapidly during the first two years of life but thereafter every year more slowly. The reduction of the rate of growth is connected with the onset of maturity.

The average lengths l_1, l_2, l_3 of autumn spawners are higher than those of spring spawners. The greatest difference is to be observed in the first year of life amounting to 2.8 cm. This difference decreases during the following years of life and in the sixth year amounts to only 0.31 cm. This is shown by the approach of the two length-curves on Fig. 2.

The higher values of l_1, l_2, l_3 of the autumn spawning herring in comparison to those of spring spawning are caused only by the first yearly length increment (t_1). This increment of the autumn spawners exceeds the one of spring spawners by 2.8 cm. The following yearly length increments t_2, t_3 of autumn spawners are lower than those of spring spawners.

The first winter ring on the scale of autumn spawning herring, born as the majority of ours are, is a later part of autumn, is formed during the

second winter of their lives. During the first winter the scale is just formed. In the case of the spring spawning herring the first winter ring is laid down during their first winter, therefore the autumn spawners at the time of the formation of the first winter ring are about half a year older than the spring spawners. Taking into consideration this difference and the higher values of the following length increments t_2, t_3 of spring spawners, we come to the conclusion that the growth of spring spawners is better than that of the autumn spawners. This can be explained by better conditions of life (temperature, food) which the newly born herring meets during spring rather than in autumn. The young spring spawning herring well fed and growing in its first year of life, is perhaps stronger than the herring born in the autumn and therefore may show better growth in the following years of its life also.

As the lengths l_1, l_2, l_3 of the autumn and spring spawning herrings show great individual variations partly in similar limits, it is not always possible to determine the race of a single fish by its scale.

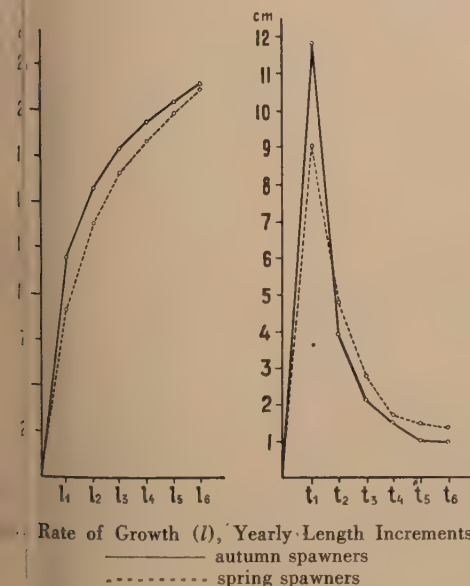
Number of Vertebrae.

As is well known, the number of vertebrae of fishes is used for the racial characteristic of different local biological groups of one species (Heincke 7, Johansen 9, Schnakenbeck 16). Some authors (Ford 6, Bjerkkan 1, Runnström 15) are rather critical of this as a racial character and are of opinion that the number of vertebrae, similarly to other morphological characters, is influenced by external conditions.

According to Davis (2, 12) "the question as to whether the distinguishing characters of herring communities are hereditary or environmental is a matter of little or no importance except as an academic recreation. The existence of area and seasonable communities is undeniable and the important point is to be able to isolate and define them".

When comparing the average number of vertebrae of the herring from different and distant areas, we usually find significant and constant differences. This average decreases from the North Sea to the south-eastern part of the Baltic in the limits of 56.5—55.0 (Heincke 7, Johansen 9, Lundbeck 11, Poulsen 14). Along the Swedish coast of the Baltic, from south to north, the average increases from 55.51—55.59 and further to the north decreases to 55.50 — north from Åland, and to 55.47 — in the northern part of the Gulf of Bothnia (Hessle 8).

The counting of vertebrae of the 1565 autumn and 930 spring spawning herrings from the Gulf of Danzig gives the following results. In the material of 1936—37, the mean —M— of autumn spawning herrings varies from 55.24 to 55.58



amounting to an average of 55.41, while of spring spawning herrings it varies from 55.19 to 55.57 amounting to an average of 55.38. The material examined during 1945—46 shows a similar but smaller variation. The average number of vertebrae —M— calculated for all autumn spawners of 1936/37 is a little higher than that of all spring spawners.

The difference between the means is 0.03 and the standard error of the difference is 0.34; as the difference of the arithmetic mean numbers of vertebrae of autumn and spring spawning herrings does not exceed its own standard error, we conclude that there is no significant difference between these means.

Comparing the highest value of M calculated for the sample containing pure autumn spawners (55.58) with the lowest one calculated for spring spawners (55.19) we obtain the result

$$\frac{M_1 - M_2}{\sqrt{m_1^2 + m_2^2}} = 3.8.$$

The difference exceeds 3.8 times its own standard error, and therefore is also not quite significant.

As the arithmetic mean number of vertebrae of autumn and spring spawning herrings from the Gulf of Danzig varies greatly from sample to sample, partly within similar limits, we cannot consider the number of vertebrae as a basis for separating these seasonal races of herrings in our waters.

The large variation of the arithmetic mean number of vertebrae of the spring spawning herring of the western Baltic caught in the same place in the different months of the year, was observed by Altnöder (Meyer, 13).

This variation may be caused by the differences in the temperature of the water owing to the long spawning season when these fishes were born, or by the presence of different biological groups of herring belonging to the same seasonal race.

It is possible that a more significant difference would emerge on comparing more selected material, but this needs further investigation.

The Length and Age Composition of the Herring Catches in the Gulf of Danzig.

The intended investigations of the length and age composition of our herring catches were carried out in order to observe the eventual changes in this composition from year to year and to determine the influence of fishing with different gears on the shoals of herring. The greater part of our material collected during the years 1936—39 is lost, we are therefore unable to make these questions clear but can make only few observations.

From the material examined (Table 1) it appears that the average length of the herring, caught by stow-nets (18 mm. meshes) varies in individual samples from 18.6 to 22.7 cm., while in those from herring-trawl catches (45—15 mm. meshes) from 18.4 to 20.9 cm., and in sprat-trawl catches (5—10 mm. meshes) from 12.7 to 19.5 cm.

The stow-nets usually catch older fishes than trawls. Dixon (5) observed that the catches of the herring trawl (18 mm. mesh) sometimes contain a large proportion of small immature herrings, 9—12 cm. in length. The same occurs when fishing with the sprat trawl (10 mm. mesh cod-end), especially when the trawl encounters scattered shoals of sprats, usually containing an admixture of small herrings.

According to Meyer (13) trawl catches of the German fishery in the Baltic yield about 50 million of the herrings belonging to 0 and I age-group yearly, which amounts to about 30% of the total German trawl-herring fishery in this area. In spite of this high percentage of young immature herrings caught every year, he has not observed any catastrophic changes in this fishery. This he explains as being the effect of a strong biological resistance of the herring.

The comparison of the length and age analysis of the autumn spawning herrings caught at Heligoland by the use of stow-nets in 1936 and 1945 shows, that the catches made in 1945 contain longer and older fishes than those in 1936 (Fig. 3 and Table 3).

The herrings in the 5th—7th year of life amount to 89% in 1945, while in 1936 only to 53.2%. The high participation of herrings bearing 5 and 6

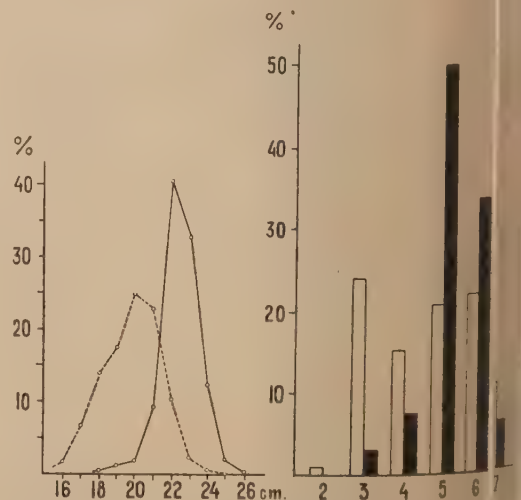


Fig. 3. Length and Age Composition of the Catches by the use of Stow-Nets (18 mm. meshes) at Heligoland.

--- □ 25.IX.—22.X. 1936; — ■ 3.X.—10.X. 1945

summer zones on the scales in 1945 is to be noted. This may indicate the strong year-classes of herring, born in autumn 1940 and 1939. The catches of spring spawning herring made in 1946 show the predominance of herring, bearing summer zones on the scales, it is the 1944 year-

class. The percentage of these fishes amounts to 58—67.6 % of the total catch.

However, these observations are based on a small amount of material and more detailed investigations of the length and age composition of the catches, in the future, are required.

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Sweden.

The Stock of Herring in the Sound and the Southern Baltic in the Years 1940—1944.

By

K. A. Andersson.

IN my paper on "The Stock of Herring in the Skagerak, the Kattegat and the Sound in 1939", this series, Vol. I, p. 161, I pointed out that there was no really strong year-class during the years 1937—39. The youngest year-class, the three-year-old one, was the strongest by percentage, but it disappeared quickly from the catches, when year by year new three-year-old year-classes appeared. The herring fishery was also very poor during these three years.

In the autumn of 1940, however, there appeared suddenly in the catches in the Sound a strong year-class of autumn-spawning herring; it was three years old and was thus hatched in the autumn of 1937. It caused the Swedish herring catches in the Sound to rise from 529 tons in 1939 to 1582 tons in 1940. This meant a threefold increase in total yield, although the intensity of fishing remained constant. This strong year-class gave even greater results in 1941: 2076 tons. In these two years it constituted about 90 % of the catches and dominated the years 1942 and 1943 by percentage, but taken absolutely it had lost its strength, the catches decreasing in 1942 to 504 tons. In 1944, the catch fell still more, to 462 tons. The predominance of this year-class in the catches during the years 1940—43 is shown in Fig. 1.

Herring caught in the Sound usually consist of autumn-spawning fish only, but in 1943 a high percentage occurred of spring-spawning fish constituting, in certain catches, more than 50 %. Taken absolutely, however, the stock was poor as the catches in 1943 were small. The age composition in this instance differed very much from the norm of the autumn-spawning herring. Among the spring-spawning herring the 1940 year-class

dominated strongly, constituting in the autumn of 1943 about 65 % of the catches of spring spawning, as will be seen from Fig. 2 which shows the age composition of a catch on October 22nd, 1943. The year-class was then 4 summers old or $3\frac{1}{2}$ years.

Annales Biologiques, Vol. I, contains a paper by Harald Alander entitled "Investigations on the Baltic Herring". The author shows that even in the southern Baltic the year-class 1937

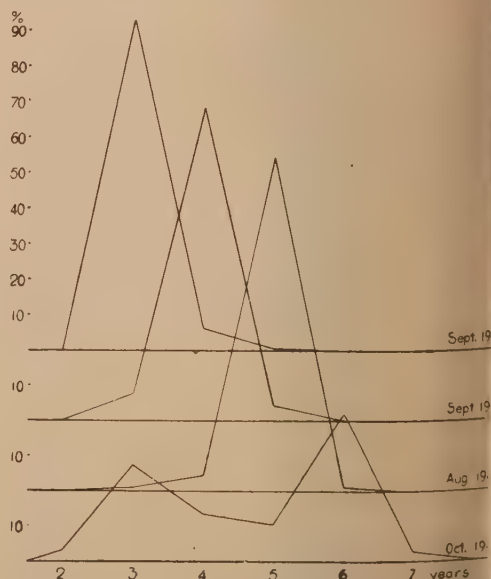


Fig. 1. Autumn Spawners from the Sound. Age Composition 1940—1943.

minated strongly among the herring catches in 1939 to 1942. In comparison with the conditions in the Sound a striking difference will be noticed: the strong year-class 1937 of autumn-spawning herring prevailed much longer here than in the Sound. Alander shows that the 1937 year-class originated good catches during 1940 to 1944. The continued examinations have proved that it was dominant also during 1943 and 1944 and good catches to the fishery. The age composition during these two years is illustrated in

the importance of this year-class to the fishery is evident from the catches. During the years 1935–44 the fishermen of Blekinge and the east coast of Scania have landed the following catches of herring:

1935	3,060 tons	1940	4,269 tons
1936	3,050 "	1941	10,019 "
1937	3,642 "	1942	10,080 "
1938	3,127 "	1943	8,491 "
1939	3,217 "	1944	8,384 "

It will be seen that the catches began to increase in 1940, but not until 1941 did the increase become really large. The strong year-class from the year of 1937 was then four years old. In 1941 the catch was more than three times greater than in 1939, and more than double that of 1940. Even in 1944, this same year-class, being then five years old, is still strong enough to give good catches.

As mentioned above it is a striking fact that the 1937 year-class predominates in the southern Baltic for so many years and is still strong in 1944 when seven years old, while in the Sound it was exhausted by the end of 1941 at an age of five years. The question arises: How does this come about? Two different explanations are possible. In the Sound, the year-class was possibly only strong enough to support a rich fishery



Map showing the area.

for two years. When it reached the age of four years, it was fished out and, though still dominating in the catch, it could no longer support a rich fishery. The following circumstance supports this explanation. In 1913, a very strong brood of autumn-spawning herring had arisen in the Sound. From 1916, this year-class supported a very rich fishery and it was undoubtedly stronger even than that of 1937. In 1916, when three years old, it supported a much greater fishery than did the 1937 year-class in 1940 at the same age. Owing

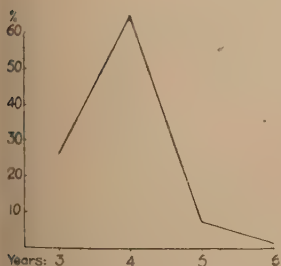


Fig. 2. Spring Spawners from the Sound. Age Composition Oct. 22nd, 1943.

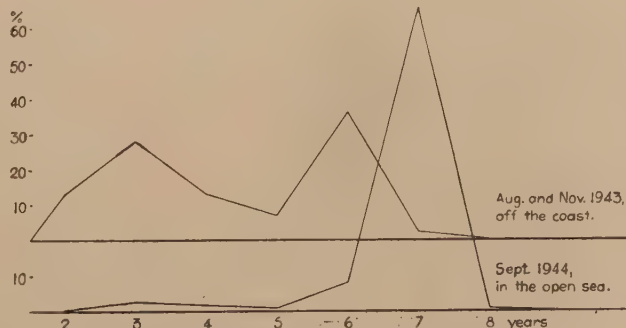


Fig. 3. Autumn Spawners from the Southern Baltic. Age Composition 1943 and 1944.

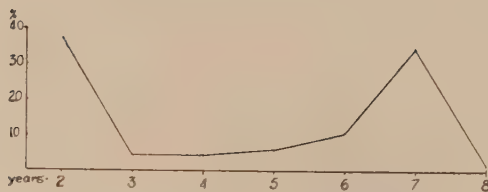


Fig. 4. Autumn Spawners caught off Simrishamn, Nov. 8th, 1944.

to its great abundance the 1913 year-class was able to support a rich fishery in the Sound until 1919 incl., when it was six years old. The fact that the rich fishery in the Sound, which depended upon the 1937 year-class, did not last more than two years (1940 and 1941), would therefore seem to be due to this year-class being insufficiently abundant for sustaining a rich fishery for a longer period.

Another explanation is also possible. In the southern Baltic observations have been made indicating that the older and larger herring migrate farther from the coasts than the younger ones. Fig. 3 gives the age composition of catches made in 1943 just off the southern and eastern coasts of Scania, and of trawl catches made in 1944 about 25' south of Karlskrona, i.e., far out in the open sea and deeper water. The coastal catches contain many small three-year-old herring, the open-sea catches, on the other hand, consist almost exclusively of large herring of the age-groups six (8%) and seven (85%).

A catch made on November 8th, 1944 just off the east coast of Scania also contained many young herrings (Fig. 4).

In the paper referred to above, Alander mentions (pp. 180 and 181) a similar observation. The Sound is only a small water and it would thus be natural to assume that the herring emi-

grate as they grow older. But this explanation hardly hold good for the disappearance of the herring from the Sound in 1942. It is undoubtedly true that the herring leaves the Sound after spawning late in the autumn, but it seems also highly probable that it returns again to the Sound in summer for spawning on the old spawning grounds; it would thus remain the object of the fishery there. This not being so, the first explanation seems in all probability to be the correct one.

It is obvious that we should like to know the cause that produced the strong 1937 year-class. In order to find, if possible, an answer to this question, we have examined the changes occurring in the water temperatures of the Sound during the period 1930—39. For this period we have daily observations from the lightvessels on Oscarsgrundet in the southern Sound and at Falsterborev (see the chart). They are published every year in the series "*Svenska Hydrografisk-Biologiska Kommissionens Fyrskjepsundersökning*", and have appeared up to 1939 incl. During the war they could unfortunately not be continued; in the case of "Falsterborev" they were discontinued in the beginning of September 1939.

As the spawning of the herring takes place chiefly in September and October these two months were examined. As the first development of the larvae may be as late as November, this month was also included. The calculated mean temperature for each of the three months was obtained.

Figs. 5 and 6 give curves of the temperature at the bottom at 8 and 10 metres depth respectively for each month at "Oscarsgrundet" and "Falsterborev". The temperature curves for 5 m. depth run almost parallel to the bottom curves. It can be seen that the mean temperature for 1939 is considerably higher than that for the immediate preceding years. It is possible that this relation

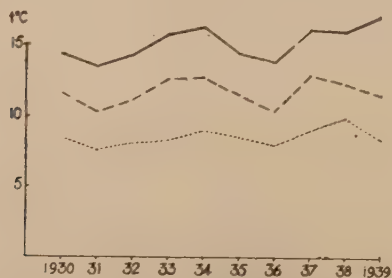


Fig. 5. Oscarsgrund, 1930—39, 8 m. depth.

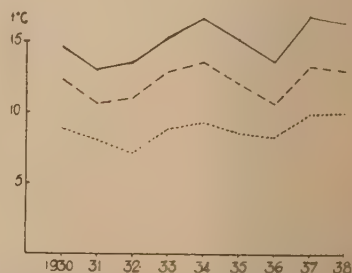


Fig. 6. Falsterborev, 1930—38, 10 m. depth.

Mean Temperatures during September—November.

— September — — — October November

temperature has been favourable for the development of the herring in the autumn of 1937. In the autumn of 1934 the water temperature was also high, and then also there originated a very strong year-class of autumn-spawning herring, though not quite as strong as that of 1937. It was caused nevertheless in 1937, when three years had passed since the remarkable increase of the fishery.

In another paper in this volume Harald Hader shows that in 1937 the temperature was also high in the southern Baltic. It may therefore be assumed that a high temperature during the spawning period and the first larval development contributes to the production of a rich year-class, even if it is not the only decisive factor. Another factor must be mentioned here which may be of importance for the production of a strong year-class, and which is referred to by J. C. Jensen in "*Fiskerens Lommebog*" (1941), p. 98. Jensen emphasizes the influence of the temperature of the first winter exerted on the larvae of autumn-spawning herring. If the temperature then is low, the larvae may perish and the production of a strong year-class can frequently be checked.

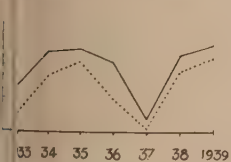


Fig. 7. Average and Minimum Surface Temperatures during February at Falsterborev.
— Average.
..... Minimum.

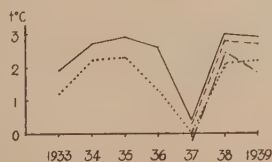


Fig. 8. Average and Minimum Temperatures during February at Adlergrund.
— Average, Surface.
..... Minimum " "
- - - Average, 10 m. depth
- · - Minimum, " "

This theory of Jensen appears very sound. In December—February the larvae are still very young. It would therefore be interesting to examine whether the water temperature was high or low during the winter following the autumn of 1937. The decisive temperature should obviously be the temperature of the month having usually the lowest water temperature. That is February. I have therefore plotted curves for the February temperatures during the period 1933—39, see Figs. 7—8. I have based the observations taken at the light-vessel "Falsterborev" from the Swedish "*Fyrskjeppsobservationerna*" and at the light-vessel "Adlergrund" from the "*Meereskundliche Beobachtungen auf den Feuerschiffen der Nord- und Ostsee*". Both light-vessels are suitably situated for this purpose. The temperature shows only very small differences at various depths. At "Falsterborev" for instance, during February 1933—36, the temperature was the same at 10 m. depth and at

the surface, and a tenth degree higher during the period 1937—39. At the light-vessel "Adlergrund" surface observations only were taken until and including 1936, but subsequently at 5, 10 and 15 m. As will be seen from the curves, the mean temperature in February 1938 was relatively high, and very low in 1937. In this connexion it may be of special importance to note not only the mean temperature, but also the lowest temperature observed during the month. It might be likely that it is just this lowest temperature that may cause a mass-extinction of larvae. I have therefore drawn curves of these minimum temperatures, see Figs. 7 and 8. They also are relatively high in February 1938, but very low in 1937. Obviously enough the temperature during February 1938 was sufficiently high that the strong brood from the autumn of 1937 could further develop. But it might also be correct to say that even if a very strong brood had originated in the autumn of 1936 it could not — on account of the low temperatures of February 1937 — have developed into a strong year-class.

The curves of the relevant temperatures show that the temperature was high also in February, 1935. As mentioned above, the year-class 1934 was relatively strong and caused in 1937, as three-year-old fish, a considerable increase of the fishery in the southern Baltic. The high temperature of February, 1935, had thus been favourable to the development of the brood of the previous autumn. There are thus two cases where the temperature seems to have been of great importance for the origin of strong year-classes.

From the above we may draw the general conclusion that, as far as the autumn-spawning herring in the Sound and the southern Baltic is concerned a relatively high temperature in September and October, i.e., the spawning period, and during the following winter, is very important for the occurrence of a strong year-class. The February temperature may even be of decisive influence.

We have unfortunately no observations of water temperatures during the winters of the years 1939 to 1944.

I have further tried to find out to what degree the salinity may have influenced the strong 1937 year-class. At Oscarsgrundet continuous salinity observations have been made three times a month, i.e., the first, 11th, and 21st in each month. They show that the salinity in the Sound is subject to great and sudden changes. Lacking detailed investigations into the salinity and the development of herring eggs and larvae it is difficult to find out the relation — if any — between salinity and the occurrence of rich or poor year-classes of herring.

The above-mentioned observations from Oscarsgrundet for September and October during the period 1930—39 provided the following mean salinity values:—

Salinity at Oscargrundet, 8 m. depth, ‰.

Year	September	October
1930	9.42	12.64
1931	10.94	14.67
1932	11.75	10.20
1933	8.44	8.92
1934	13.54	17.18
1935	13.04	15.31
1936	11.29	11.94
1937	13.01	8.55
1938	8.28	16.67
1939	19.27	17.19

The variations between one year and another and between one month and another are often great, and even for adjacent years there may occur within the two months variations going in opposite directions. The available Swedish observations will hardly permit of proving any relation between salinity and the occurrence of strong year-classes of herring in the Sound.

In my above-mentioned paper in this series, Vol. I, I have discussed the variations in the growth-rate of herring in the Sound and proved that the growth-increment of herring was considerably greater during the years 1937—39 when the stock of herring was very poor than in 1916 when the stock was rich. A comparison between the length of three-year-old herring from these years shows that the herring in 1939 was about 3 cm. larger than in 1916. I suggested that this difference in growth might be due to the herring stock being much thinner in 1939 and the immediately preceding years, than in 1916, so that the food at the disposal of each herring was much more abundant in 1939 than in 1916. It seems now to be of great interest to find out the details of the rate of growth in 1940, when, as mentioned before, a new strong year-class occurred which suddenly caused a very large increase in the catches.

The Swedish herring catches from the Sound during the relevant years were as follows:—

Year	Tons	Year	Tons	Year	Tons
1916	7,640	1937	857	1941	2,076
1917	7,470	1938	439	1942	504
1918	5,427	1939	529	1943	500
1919	3,740	1940	1,582	1944	462
1920	2,972				

These figures give a good representation of the variations in the strength of the herring stock during the years in question. The strong increase during the years 1940 and 1941 did, however, not reach the high values of 1916 to 1920. The first-named two years hold an intermediate position between 1916 and 1939. The rich fishery during 1916 and following years was supported by the 1913 year-class. The preponderance of this year-class over

that of 1937 may also be judged from the fact that it sustained a rich fishery until 1920 incl. for 5 years. The year-class 1937 gave the basis for profitable fishery for two years only, 1940 and 1941.

In the above-mentioned paper I have examined the lengths of three-year-old herring and have done the same for three-year-old herring in September 30th, 1940. 164 fish were examined and showed a mean length of 21.15 cm. A comparison of this length with that of three-year-old herring at the same time in the years 1916 and 1939 gives the following values:—

Sept. 22nd, 1916	19.68 cm.
Sept. 25th, 1939	22.95 cm.
Sept. 30th, 1940	21.15 cm.

Other samples from these years have practically the same length. The length in 1940 holds an intermediate position between the lengths in 1916 and 1939. Assuming that the different densities of the herring stocks are the cause of the varying lengths, it is in good agreement with the assumption that the year-class 1940, as far as density is concerned, holds an intermediate position between 1916 and 1939. This would consequently prove that the growth-rate of the herring — as that of certain bottom fishes — is highly dependent upon the greater or lesser food supply for each fish. As the density of the stock increases the growth-rate decreases, and as the density decreases the growth-rate increases.

Fig. 9 gives the length curves of the various lengths for three-year-old herring during the years 1916, 1939 and 1940.

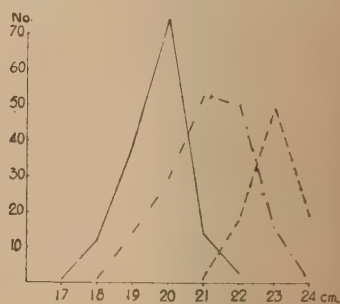
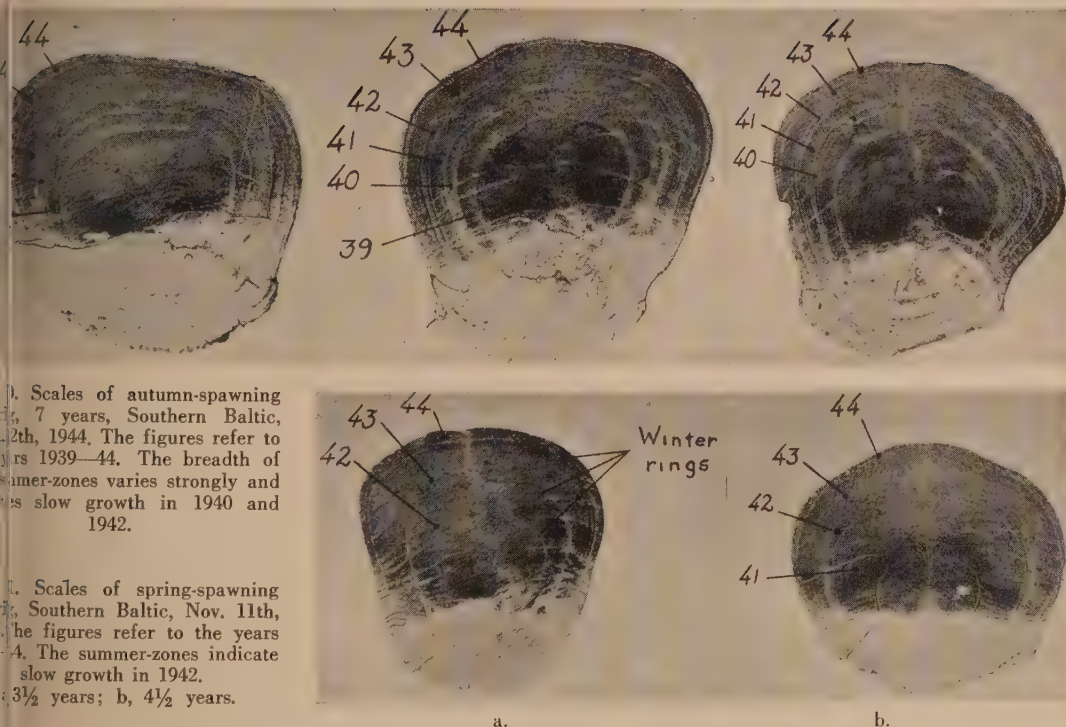


Fig. 9. Length of 3-year-old Autumn Spawners from the Sound in 1916, 1939, and 1940.
— Sept. 22nd, 1916.
--- Sept. 25th, 1939.
..... Sept. 30th, 1940.

When analysing the scales of herring from the southern Baltic of 1944 the breadth of the summer-zone is found to vary very strongly.

The summer-zone of 1942 is almost always



10. Scales of autumn-spawning herring, 7 years, Southern Baltic, Nov. 12th, 1944. The figures refer to the years 1939—44. The breadth of the summer-zones varies strongly and indicates slow growth in 1940 and 1942.

11. Scales of spring-spawning herring, Southern Baltic, Nov. 11th, 1944. The figures refer to the years 1941—44. The summer-zones indicate slow growth in 1942. a, 3½ years; b, 4½ years.

and much smaller than that of 1943. For transitions are found from almost normal — in very rare cases — to an extremely narrow zone. Fig. 10 shows three scales of seven-year-old autumn-spawning herring, which give evidence of this fact.

The fact that the zone of 1942 is abnormally narrow is undoubtedly the result of a slow growth during the year in question. Sometimes the zone is so narrow that the growth must have been extremely small.

This holds good not only in case of the autumn-spawning herring, but also of the spring-spawning herring. Fig. 11, a and b, shows two scales of seven-year-old herring; a shows the scale of a seven-year-old herring, the 1942 zone of which is much narrower than that of 1943. Normally, it is to be the reverse. b shows the scale of a seven-year-old herring with a very narrow 1942-zone. In the summer-zone of 1940 is generally considerably narrower than normal, Fig. 10. In 1940 also the growth was generally slow, not as slow as in 1942.

The slow growth during 1942 and — though to a lesser degree — during 1940 also must have been caused by the low water temperature prevailing during both years.

In another paper (p. 148) A l a n d e r has dealt with the temperature conditions in the Baltic dur-

ing the years 1937 to 1944. It appears that the temperature in the southern Baltic was extremely low during 1942, which might explain the slow growth during that year. In 1940 also the temperature was low, though higher than in 1942, which seems to agree well with the slow growth in 1940.

The summer-zones for 1941 and 1943 are as a rule relatively broad, thus indicating a good growth during both years. A l a n d e r shows also that the temperature was relatively high during these years. The growth-rate during the various years agrees fairly well with each year's temperature curve.

A l a n d e r has also examined the variations of salinity which, however, do not seem to have had any influence on the growth of the herring. The temperature could well be expected to be the main factor influencing the growth, having, as it does, the greatest influence upon the consumption of food.

In the above I have tried to prove the correlation between the growth of the herring and the density of a year-class, assuming that on this latter factor depends the supply of food for each herring. In the last part of the paper I have demonstrated the correlation between growth and water temperature. But in both cases the real question is the relation between growth and food consumption. The amount of food consumed is obviously the decisive factor for growth.

Investigations on Herring in the Baltic.

By

Harald Alander.

IN Vol. I of this series I have written a paper on the age composition of the stock of autumn-spawning herring within various parts of the Baltic during the years 1939—42. During that period the stock of herring in the southern Baltic was absolutely dominated by autumn spawners of the 1937 year-class which constituted about two-thirds of the catches. In the central Baltic, the situation was almost the same, but the percentage of other year-classes, especially that of 1936, was somewhat greater. In the Gulf of Bothnia the two rich year-classes 1936 and 1937 formed the bulk of the stock, the percentages of other year-classes, however, specially those of older ones, were rather considerable. After 1937, the recruitment of the stock seemed to have been poor within the whole Baltic, and a strong decline in the supply was anticipated for the period after 1942, since previous investigations seemed to have proved that a herring year-class of more than five years could not generally be effectively fished in the southern Baltic. A good year-class in the Gulf of Bothnia could perhaps be expected to last somewhat longer.

The investigations carried out from the research vessel "Eystrasalt" during 1942—44 were mostly directed towards the question whether a stronger recruitment of the herring stock was to be observed or whether the fishery had to continue to be based upon the same year-classes as before.

In these fishery experiments nets were generally used and it was emphasized that various sizes of mesh should be employed in order to reduce as much as possible the selective action of the gear upon the composition of the catch. Furthermore during the last two years in some instances the trawl was used.

On the conditions in the southern Baltic Dr. K. A. Andersson has already given a report in this volume (see p. 166), and I shall therefore restrict myself to some special observations. In 1943 herring were caught which proved to differ in age composition from those caught in previous years. The dashed line in Fig. 1 gives the age composition of such a catch taken close off the coast of Skåne. The percentage of the six-year-old fish of the 1937 year-class is certainly rather remarkable, but still

barely half of what it used to be in the preceding years. On the other hand the percentage of the younger year-classes — especially those three or four years old — was large. It would thus seem as if the anticipated recruitment of the stock was in fact going to be realized. At the same time the trawl-catches were obtained in deep water in the Bornholm area. Their age composition is given in Fig. 1 by the solid line which shows that the 1937 year-class dominated in these catches to the same extent as before. According to information received from fishermen, herring stocks in which the young age-groups predominate were found only in a very narrow zone off the coasts. Farther out into the sea — beyond 10 dist. minutes — there was no trace of the smaller herring. The young age-groups seem to keep rather near the coast — at least temporarily — while the older age-groups migrate farther out into the sea and to deeper water. In 1944, we expected again to find the young age-groups in the catches, but however eagerly we searched, we did not meet any appreciable amount of young herring. According to K. A. Andersson's paper the 1937 year-class continued to dominate as formerly. The younger age-groups met with in 1943 had probably spread over a larger area so that they were almost completely hidden by the still strong 1937 year-class.

In case the reproduction of the stock had been only tolerably good during the last years and the herring had not been trawled in the Baltic, the

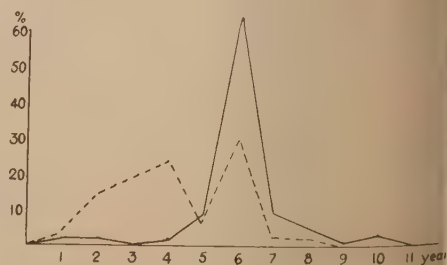


Fig. 1. Age Composition of Herring caught in the Southern Baltic in the Autumn of 1943.
 ----- Autumn spawners taken with nets off the coast.
 ————— Autumn spawners taken by trawl.

ass would hardly have been of any importance the last two years. By trawling, however, herring could be fished at such times of the year when the net fishery did not give any results. This is clearly connected with the above-mentioned tendency of the herring to migrate farther away from the coast and to deeper water as they grow older, and to migrate to the coasts only at spawning-time. In the central Baltic conditions seem generally to have been similar to those in the southern Baltic. Fig. 2 which gives the percentages of the composition of the herring catches taken during the years 1942—44. The dashed curve shows the composition of a catch taken in the waters off Landsort during July, while the solid curves

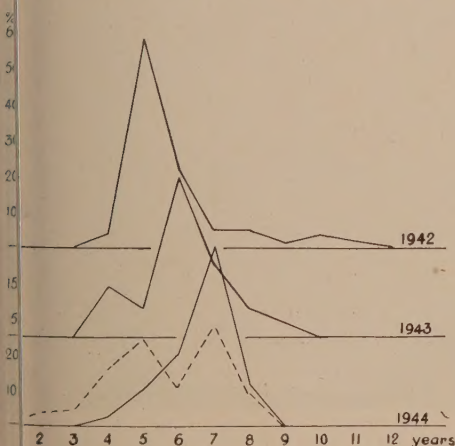


Fig. 2. Age Composition of Autumn-Spawning Herring from the Central Baltic, 1942—1944.
— Herring caught off Landsort during July, 1944.
— Spawning herring from the northern ground of Öland.

herring from a sample taken at the North Ground of Öland at the end of September. It is interesting to see how the conditions are similar to those prevailing in the southern Baltic in 1943. The herring in the summer the older herring probably migrated to deeper water between the Swedish mainland and Öland and have migrated to shallower water at the time of spawning. Since trawling is not permitted in the central Baltic and the extensive trawling experiments did not permit trawling experiments to be carried out in these waters by the "Eystra", it was impossible to verify the supposed early migrations of herring in the central Baltic. Fig. 3 gives a representation of the stock of autumn-spawning herring in the Gulf of Bothnia during the periods 1939—40 and 1942—44. In the beginning the 1936 year-class proves the most important, but during recent years the 1937 year-class has turned out to be of similar importance. It is remarkable that the percentage of older herring is quite considerable in the Gulf of Bothnia,

even in those catches that were made close to the coasts. Some fishery experiments with nets, however, made farther out in the sea during the autumn of 1943, showed that the older age-groups were somewhat denser there than in the coastal waters. Quite astonishing results, however, were obtained by some trawling experiments carried out off Agö during September 1944. The difficult

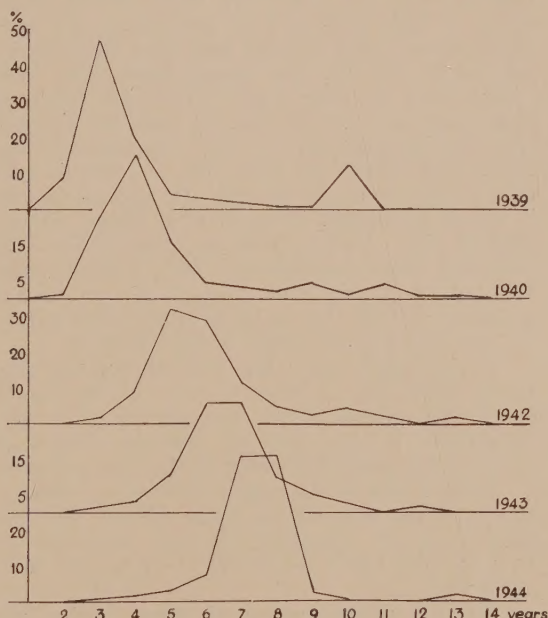


Fig. 3. Age Composition of Autumn-Spawning Herring from the Gulf of Bothnia, 1939—40 and 1942—1944.

bottom conditions made it almost impossible to drag the trawl over any longer distance. Each haul lasted generally not more than 5—10 minutes, and big catches could therefore not be expected. In a few instances, however, quite satisfactory catches were obtained. About 8 dist. minutes south by east of "Agö" lighthouse, for instance, at 80—90 m. depth, 5 kg. of large and weighty herring were taken in a 13 minutes' haul, which shows that the stock of herring must have been quite considerable at this depth.

Some years ago K. A. Andersson (Fiskeriologiska undersökningar i Östersjön och Bottniska Viken. Meddel. från Kgl. Lantbruksstyrelsen, No. 243, 1923) had already pointed out that herring were found in the stomachs of cod caught at great depths in the Gulf of Bothnia, and this implied that herring in these waters also lived in the greater depths. These trawling experiments could thus definitely prove the correctness of this implication.

Although it is very interesting to have proved the presence of herring at great depths in the Gulf

of Bothnia the results of the age analyses of the trawled herring catches seem to be even more striking. Fig. 4 gives the age composition of the above-mentioned catch. The dashed curve shows the percentage of spring-spawning herring while the solid curve denotes the autumn-spawning herring. The high percentage of spring-spawning herring is already remarkable since the stock of these herring had been very small during recent years. A large part of these spring-spawners were about eleven years old and they were undoubtedly the last of the rich year-classes from about 1930—35 which in later years (1936—40) were of such importance to the fishery. Also the autumn-spawning herring show a very characteristic age composition which has very little in common with that of the net-caught catches. Of special interest is the unmistakable proportion of about fifteen-year-old fish. Some autumn-spawners of the 1929 year-class were undoubtedly still present; they had played an important part in the net fishery as late as in 1939, but could in recent years hardly be ascertained in the usual herring catches.

As indicated above the trawled herring were fairly large. Fig. 5 gives a curve of the length distribution which shows that herring of a size remarkable in the Gulf of Bothnia constituted quite a large part of the stock in the deeper waters.

Another fact is also worth mentioning: examinations of the stomach contents showed that the chief food of net-caught herring consisted of copepods, while the trawled herring had lived on *Mysis*.

The age determinations of older herring are often encumbered with certain difficulties. It is very usual that, with declining growth-rate and advancing age, the age-rings in the scales become narrow and indistinct and consequently indistin-

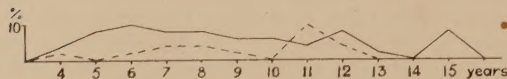


Fig. 4. Age Composition of Trawled Herring from Deep Water in the Gulf of Bothnia, September 1944.

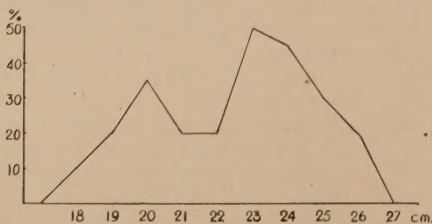


Fig. 5. Length of Trawled Herring from Deep Water in the Gulf of Bothnia, September 1944.

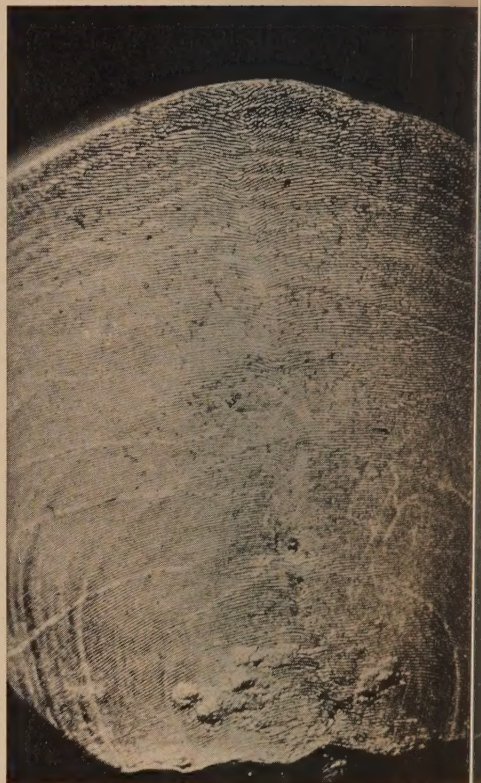


Fig. 6. Scale of an Autumn-Spawning Herring, about 15 years old, trawled in deep water in the Gulf of Bothnia, September 1944.

guishable. The greater number of the trawled herring — also the older ones — showed however quite distinct age-rings, as will be seen from Fig. 6 giving the scale of an autumn-spawning herring. It is evidently quite justified to set its age at about fifteen years.

From the above it may be concluded that in the Gulf of Bothnia also, as in the other parts of the Baltic, the herring as they grow older change their habits and do not migrate to the same grounds as the young fish. In their first years they live quite near the coast in shallow water and later they migrate farther away from land and to deeper water. In connexion with spawning they undoubtedly return to the spawning grounds off the coast, but it is perhaps doubtful whether the oldest herring do take part in spawning. Maybe the main during the last part of their life out in deep water.

The above-mentioned investigations have been carried out on a somewhat limited scale and must be continued so that the results may be confirmed.

